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Pat Beattie

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ORIENTATION AND WAYFINDING

Prepared for:

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U.S. Architectural and Transportation Barriers Compliance Board
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CONTENTS

SECTION ONE
State-of-the-Art Review of the Literature 1.4

Introduction 1.4
  Problem Statement 1.4
  Purpose 1.4
  Sources Reviewed 1.4
What is Wayfinding? 1.5
  Overview 1.5
  Adults and the Process of Finding One's Way 1.5
  How New Places are Negotiated 1.5
  Storing Information 1.5
  The Advantages of Newcomers Vs. Oldtimers 1.6
  Children's Spatial Awareness 1.6
  Adolescents 1.7
  Disorientation and Aging 1.7
  Males, Females, and Knowledge of Place 1.9
  Get Lost 1.9
  ng Be Done
  iciencies 1.11
  1.11
  ncrete Vs. Abstract Information 1.11
  Mapping and Map Reading 1.11
  Becoming More Mobile 1.12
  Orienting to Different Points of view 1.12
  General Training and Self-Help 1.13
Special Users, Special Needs 1.13
  User Needs of Blind People 1.13
    Concept Development 1.13
    Decision Making 1.13
    Using Sequential vs. Simultaneously Presented Cues 1.14
    Maximizing the Memory Requirements 1.14
    Knowledge of Turns 1.14
    Gathering Information on Distances 1.14
    What Happens When Information is Out of Context? 1.15
    Hazards and Confusion Posed by Crowding and Restricted Pathways 1.15
    Travel in Adverse or Inclement Weather 1.15
    Sources of Design Inspiration 1.16
  User Needs of Persons with Low Vision 1.16
    Location and Use of Signs 1.17

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Prepared by:
Bruce Blasch
and
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Under the direction of the:

National Center
for a
Barrier Free
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SECTION ONE

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Introduction 1.4
  Problem Statement 1.4
  Purpose 1.4
  Sources Reviewed 1.4
What is Wayfinding? 1.5
  Overview 1.5
  Adults and the Process of Finding One's Way 1.5
  How New Places are Negotiated 1.5
  Storing Information 1.5
  The Advantages of Newcomers Vs. Oldtimers 1.6
  Children's Spatial Awareness 1.6
  Adolescents 1.7
  Disorientation and Aging 1.7
  Males, Females, and Knowledge of Place 1.9
Why People Get Lost 1.9
Can Anything Be Done About Deficiencies 1.11
  Naming 1.11
  Using Concrete Vs. Abstract Information 1.11
  Mapping and Map Reading 1.11
  Becoming More Mobile 1.12
  Orienting to Different Points of view 1.12
  General Training and Self-Help 1.13
Special Users, Special Needs 1.13
  User Needs of Blind People 1.13
    Concept Development 1.13
    Decision Making 1.13
    Using Sequential vs. Simultaneously Presented Cues 1.14
    Maximizing the Memory Requirements 1.14
    Knowledge of Turns 1.14
    Gathering Information on Distances 1.14
    What Happens When Information is Out of Context? 1.15
    Hazards and Confusion Posed by Crowding and Restricted Pathways 1.15
    Travel in Adverse or Inclement Weather 1.15
    Sources of Design Inspiration 1.16
  User Needs of Persons with Low Vision 1.16
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- Directing Vision to Immediate Travel Surfaces 1.17
- Fluctuations in Vision as a Function of Changes in Height and Weather 1.17
- Riding and Wayfinding 1.18
- Crowds and Low Vision 1.18
- Design References 1.18
- User Needs of Persons with Color Deficiencies 1.19
- User Needs of Persons with Color Deficiencies 1.19
- User Needs of Hearing Impaired and Deaf People 1.20
  - Communication and Aging 1.20
  - Environmental Functioning 1.20
  - Modifications to the Environment 1.21
- User Needs of Persons with Developmental Disabilities 1.21
  - Signs 1.22
  - Right angle Turns and Paths 1.22
- User Needs of Persons with Learning Disabilities 1.22
  - Uniformity of Spatial Layout 1.22
  - Slight Turns 1.23
  - Making Instantaneous Decisions 1.23
  - Distinctive Cues and Landmarks 1.23
- Spaces and Elements 1.23
  - General Consideration 1.23
  - Building Layout 1.23
  - Circulation Areas and Egress Paths 1.24
    - Circulation and the General Population 1.24
    - Route and Hallway Knowledge 1.24
      - General Public 1.24
      - Special Users 1.24
    - Risks 1.25
    - Minimizing Confusing Choices 1.25
  - Decision Nodes 1.25
  - Rooms and Spaces 1.26
  - Signage and the General Population 1.26
  - Signage and Special Needs 1.27
  - Landmarks and Reference Points 1.28
  - Tactile Materials 1.29
- New Technologies 1.34
  - Technology for Visually Impaired Persons 1.34
    - Environmental Technologies 1.34
      - Talking Signs 1.34
      - Orientational and Navigation devices 1.35
      - Auditory Marking 1.35
      - Street Crossing Signals 1.35
    - Aids and Guides Worn or Carried by the User 1.35
      - Russell Pathsounder 1.36
      - The Laser Cane 1.36
      - The Sonicguide 1.36
      - Environmental Sensors 1.37
    - Technologies and Map Making 1.37
    - The Use of Orientation Aids 1.37
  - Technology for Hearing Impaired Persons 1.38
    - Medium Level Technologies 1.38
    - Portable Systems 1.38
      - Multi-purpose Signaling Systems 1.38
      - Sonic Alert 1.38
      - Portable Products for Communication 1.39
      - Portable and Semi-portable Products for Information Gathering and Communication 1.39
    - Handling Emergencies 1.39
    - The Teletypewriters (TTY) and Telecommunications Devices 1.39
    - Comments on Technology Enhancements and Hearing Impaired Users 1.40
      - Computers as Aids to Wayfinding 1.40

Limitations of Computer Technologies 1.42
Hazardous Elements Such as Stairs 1.43
Overview of the Impact of Current Building Code Regulations 1.44
Introduction 1.44
What Areas are Covered in Building Codes Pertinent to Wayfinding? 1.44
What Spaces or Decision Nodes are Vulnerable to Disorientation and Therefore Need Some Indicators or Signs? 1.44
What Objects or Features Should be Identified for the Users? 1.44
What Special Information on or About Signs is Required or Recommended? 1.45
Do the Preceding Topics Express the Issues? 1.45
Inconsistencies in Spaces Singled Out For Labeling 1.45
Contradictions in Terms of Wheelchair Users 1.46
Height of Signals and Controls 1.46
Route Marking 1.46
Specifications for Visually Impaired Users 1.46
Need for Contrast 1.46
Need for Print Legibility 1.46
Need for Tactile Signs and Research on Tactile Signs 1.46
Signs Need to be Within Visual and Tactile Range 1.46
Lighting Must be Considered in Relation to Signs or Cues 1.47
Color 1.47
Hearing Impaired Users 1.47
Supplementary Materials 1.47

SECTION TWO

Annotated Bibliography 2.1
List of Authors from Annotated Bibliography 2.1
List of Authors by Topic 2.2

SECTION THREE

Research Needs 3.1
Introduction 3.1
Wayfinding Research 3.2
Research Need 3.2
Proposed Research 3.2
Signage 3.4
Research Need 3.4
Proposed Research: Optimal Sign Locations 3.4
Proposed Research: Optimal Sign Characteristics 3.5
Proposed Research: Contrast 3.6
Proposed Research: Methodology 3.6
Proposed Research: Raised vs. Recessed Letters 3.6
Proposed Research: Symbols 3.7
Building Configuration 3.7
Research Need 3.7
Proposed Research 3.7
Training 3.7
Research Need 3.7
Proposed Research 3.7

Bibliography of Resources Cited in Section I 3.9

APPENDICES

A. Tables from the Work of Dr. Templer on Tactile Surfaces, Recommendations and Detector Methods 3.18

B. Analysis of 40 U.S. Building Codes and Regulations Pertaining to Orientation and Wayfinding 3.20

C. Results of Pilot Survey of Information Requested for Technical Paper on Signage 3.34

INTRODUCTION

This report and analysis was prepared for the National Center for a Barrier Free Environment on behalf of the Architectural and Transportation Barriers Compliance Board.

Problem Statement

The document is directed toward the topic of wayfinding and the problems people of various disabilities experience in orientation. This work was requested because there is currently very little consolidation of such information and no consensus on the best methods for providing signs, signals and directions.

Purpose

The purpose of this literature review is to profile what is known about wayfinding and orienting systems, and to stipulate why that information seems either reliable or tentative in terms of documented needs of persons with handicapping conditions.

Many "arm chair" suggestions have been advanced regarding orienting systems for disabled persons. Those which seem to meet documented needs have been substantiated. Those which are inconsistent with the data on wayfinding are questioned.

Review of literature and available research suggests that there are no answers based on data, for the most part, to many of the issues raised. While there is often peripheral information supportive of one limited aspect or another, the reader is advised that further research on the topics outlined here will be essential before dependable design recommendations can be implemented.

Sources Reviewed

The literature surveyed here is fairly recent, in part because most research has been conducted only since 1960 and in part because of limitations of the time available to conduct the task (a period of two months).

Social Sciences Index was a major source of references for the bibliography. Topics reviewed from 1978-1982 included: orientation, disorientation, color, sign(s), perceptual geography, environmental design, handicap, disability, architecture, aging, space, and maps.

Because of the apparent lack of data-based material, Dissertation Abstracts International (1977-1982) were checked on the assumption that doctoral dissertations might provide some of the necessary information.

Rehabilitation International, Rehabilitation Literature and the Journal of Gerontology each carry regular bibliographic features which were similarly checked. Many of the books and articles cited were found somewhat serendipitously. Some were found during the course of the authors' research or were suggestions of those contacted in telelphone interviews.

Resource people contacted and cited in the review were suggested to us in large part by the Architectural and Transportation Barriers Compliance Board and by the National Center for a Barrier Free Environment. Names were added to the list; their selection was based upon the types of research being published or the names which appeared in the literature.

As with any such review, many more sources of people and information are known that should have been tapped and we can only hope that this technical paper and the draft review process will serve to stimulate others to contact the sponsors and make their contributions known.

WHAT IS WAYFINDING?

Overview

Before launching a discussion of the "special" orientational needs of handicapped users, it may be useful to summarize some contemporary information available on the process and goals of orientation itself. This information suggests that (a) many so-called "able" pedestrians share certain aspects of disorientation with so-called "handicapped" persons, and (b) there is some indication that efforts to satisfy the orientational needs of special users may indeed benefit a broad segment of the public as a whole.

Adults and the Process of Finding One's Way

The sections of the brain which are most specifically involved in wayfinding include (1) the occipital lobe (visual capacities), (2) the parietal lobe (controlling tactile and motor capacities), and (3) temporal sections of the brain (auditory-vestibular sections) (Siegel & White, 1975; Wiener, 1980; Pick, 1980; Aust, 1980).

Some have suggested that if it were possible to replace the eye of visually impaired persons, orientational abilities would improve (Clark & Gosnell, 1981). However, research to date suggests that far more is involved in orientation than the visual system alone. Because of its involvement of many other senses, it is vulnerable to malfunction for a variety of reasons. For example, mobility plays a key role in the knowledge of space and direction (Siegel & White, 1975) and even an individual's social experiences may be important to wayfinding (Kozlowksi & Bryant, 1977).

How New Places are Negotiated

One of the controversial issues in wayfinding involves the question, "how do we use the environment to navigate?" (Evans, 1980).

Two models exist for how people become familiar with a new space. Appleyard (1960) and Lynch (1960) contend that people learn a new setting by learning paths and districts. Later, they become familiar with landmarks. Hart and Moore (1973) and Siegel and White (1975) contend that environmental learning depends first upon learning landmarks and then developing a knowledge of paths.

Interestingly, the latter two sets of authors studied children while the interest of the former two has been more with adult populations. Efforts to confirm either proposition in the laboratory and the field have been inconclusive (Evans, 1980).

Evans (1980) asserts that adults tend to encounter a new environment and learn routes first and later construct and use cognitive maps. The importance of this relates to the type of information offered in an environment or through other personal methods. It seems likely that both landmark and route knowledge are important, but there is little comparative work on the best mode of presentation for each.

Storing Information

Here again, two views are advanced (Evans, 1980). One holds that information is stored as lists or abstract representations. This has been called a "propositional view". The practical implications would suggest that labels, names and signs would be very important to how one negotiates environments. The research in this area is concerned with words, semantics and techniques for representing space and routes.

A second concept suggests that information is stored as some "picture in the head" or actual map. The implication is that how things look and their imageability as a whole is relevant to our ability to move in an environment. It may be that individuals store information differently or change developmentally. The importance of this controversy relates to how information might be presented to make it easiest to remember and how storage processes might affect people with specific types of impairments, such as those experienced by blind people.

One study (Thorndyke & Stasz, 1980) has indicated that visual memory alone is insufficient to explain our knowledge of place; another (Pezdek & Evans, 1979) suggests that memory for names is recalled somewhat differently and independently from our ability to hold onto pictorial images. It appears that relying on visual form or imageability alone or signage alone may deny the public information necessary to a full understanding of a building or geographic area.

The Advantages of Newcomers vs. Oldtimers

Are newcomers at a disadvantage with respect to knowledge of a building or community?

Evans (1980) summarizes research by noting that some studies have shown that newcomers do more exploring and may use more areas than do longer term residents, giving them some advantages in knowledge of a place (p. 274). Newcomers may pay attention to details whereas oldtimers may be ignorant of signs or directional cues, paying more attention to symbolic or social information or even negotiating virtually mindlessly.

Children's Spatial Awareness

Until quite recently, the thinking of behavioral scientists on how orientation develops was based on Piaget's models of child development (Piaget, 1929, 1954, 1971; Hart, 1979). Piaget proposed that spatial comprehension proceeds through a logical ordering of three levels of space, and that at different ages children acquire different skills in spatial awareness.

The first level, topological, included knowledge of objects, their proximity, their separation or extent of continuity, and their degree of closure. At this level, a child requires motor behavior and tactile experience. Researchers of handicapped children have related these factors to various conditions which retard or slow knowledge of space (Mills, 1980; Blasch & Welsh, 1980; Hill & Blasch, 1980).

At a second level Piaget calls propriative, children begin to understand interrelationships of objects in space; they may perceive objects from many different angles; they come to distinguish shapes and forms. However, at this stage they tend to relate much of what they know to their own bodies using what has been termed "egocentric" orientation.

The third level of development proposed by Piaget is called metric. At this point, children become more skilled with concepts of angularity, they can deal with abstract coordinates and are less dependent upon their own body positions to imagine and use directions.

Is this really "how it is?" Contemporary research has taken the theory apart, researching various components without clear-cut consensus on the results.

The problem may not be the theory but the lack of research that traces children developmentally through their progressive knowledge and use of environment. (A noteworthy exception is the research of Hart, 1979.) Therefore, other theories have been advanced, as well.

Seigel and White (1975) have proposed a model of "Main Sequences" to describe how children come to use and know space. The steps include:

1. notice and rememberance of landmarks,
2. route learning or use of landmarks from point-to-point,
3. development of clusters or "mini-maps", well-organized within themselves, but often unrelated to any larger scale notion of the environment.
4. objective differentiation of self from the environment; that is, being able to improve the notion of outside features and boundaries independent of the child's body position, and
5. formation of mental "survey maps" which include larger representations of space.

Allen et al. (1979) compared the orienting abilities of second and sixth graders and college students in a simulated walk and their abilities to use landmarks. They found that the two younger age groups did not spontaneously use the same features and landmarks as did the college-aged adults. Adults select reference points at actual nodes or choice points; whereas children may recall interesting landmarks which have no bearing on turns and make turns without noting the landmarks.

Adolescents

At a cultural level, adolescence may be associated with successive increases in freedom, changes in body size and mental abilities, and increased social independence growing from abilities to handle money, ride or drive, and even work.

Consequently, it may be at this age that knowledge of spatial arrangements and way finding becomes most significant. Researchers have commented on how little is known about wayfinding by adolescents (Evans, 1980) except for the orientation and mobility work done in schools for blind children (Welsh & Blasch, 1980).

There is a cross-cultural account of environmental cognition and mapping impressions of adolescents (Appleyard, 1980); however, it does not offer information on U.S. young people and on topics of environmental design and perception.

Disorientation and Aging

Very little documentation has been presented on how older people who live in communities, who are not in institutions, who are relatively free from memory or other impairments negotiate space (Evans, 1980). However, it is often presumed that disorientation is a likely problem of older people (Welsh, 1980; Nowakowsky, 1980).

There is some evidence that older people revert to a pattern associated with children, that is, being egocentric and using themselves as a point of reference (Evans, 1980).

Research on learning suggests that while elderly people can and do continue to learn (Baltes & Schaie, 1974; Hartley, Harker & Walsh, 1980), they are slower to make spatial judgments (Birren & Renner, 1977; Birren, Woods & Williams, 1980).

Probably the most salient factors affecting orienting abilities of older people are the following:

1. Diminished mobility from whatever cause may limit one's experience in the environment (Corso, 1981; Shanas, 1980). Researchers writing on the prevention of falls (Overstall & Isaacs, 1978; Toglia, 1975; Waller, 1978) and accidents (Vision..., 1980) indicate that there should be ways to encourage mobility rather than sedentary behavior which might ultimately minimize some of the effects of disorientation and immobility (Butler, 1977-8; Hiatt, 1981) which result from lack of exercise.

2. Diminished vision is a major factor in orientational difficulties of older persons (Fozard et al., 1977; Fozard, 1981), some of which could be minimized by improved lighting (Lefitt, 1980; Cullinan, 1978) and reducing glare (Fozard, 1981; Hiatt, 1980). The lens of the eye yellows with age, resulting in changes in the perception of color (Vaughan et al., 1979; Fozard et al., 1977) and limiting the utility of color coding (Hiatt, 1980a,b). Ways for improving the legibility of environments have been suggested if not substantially researched (Hiatt, 1978; Windley & Scheidt, 1980; Pastalan, 1979; Koncelik, 1979).

3. Difficulties in hearing and the vestibular systems may complicate auditory information on routes and hazards (Corso, 1981; Pick, 1980; Bender, 1975; Toglia, 1975). Some of this distortion could be reduced by minimizing or removing stressful background noise (Fozard, 1981; Corso, 1981; Sayre, 1980).

4. Diminished attention span ("attentional deficits") affect the ease with which older people automatically follow routes, drive, or orient themselves to new places (Cohen & Wu, 1980; Cohen & Eisdorfer, 1979; Langer, 1980). Again, some of this might be minimized by simplifying the presentation of information in environments and slowing the demand for quick responses (Windley & Scheidt, 1980; Fozard, 1980).

5. Organic changes, such as Alzheimer's disease, though affecting only about 10% of all elderly people, may be a major factor in disorientation (Alzheimer's Disease, 1981; Siegler, 1980; Miller & Cohen, 1981; Morely et al., 1980; Mortimer et al., 1981). Even here, some success has been experienced through training (Zarit, Gallagher & Kramer, 1975; Zarit, Zarit & Reever, 1982).

6. Slowing of response rate (Birren, Woods & Williams, 1980) may also result in some complications affecting orientation. It has long been suggested that pedestrian crossings, elevators and revolving doors be adjustable for those who cannot pass so quickly (Lindsey, 1964).

7. Stress and difficulties in coping with stress may produce temporary disorientation (Eisdorfer & Wilkie, 1977; Chiriboga & Cutler, 1980; Horwitz & Wilner, 1980). (See Why People Get Lost, page 13.)

8. One may perceive him/herself to be lost or disoriented as the result of several factors. Persons may have too little information about their impairment or on ways of compensating for vision, hearing or other disabilities. They may have little or no information on how the environment influences their awareness of location (Hiatt, 1982; Cullinan, 1979; Fozard, 1981). There are some indications that specific training and practice in wayfinding might benefit older persons and prevent some of the disorientation experienced (Quayhagen, 1979).

Despite the changes associated with aging, being old should not, in and of itself, be equated with being disoriented or having problems in identifying one's location.

Very few observational or verbal studies have been done on the spatial abilities and wayfinding needs of older people as they negotiate real world environments. Yet it is quite likely that the majority of those persons who could benefit from environmental improvements would be older persons. Elderly persons typically account for the majority of visually and hearing impaired indviduals (Welsh, 1980; Kirchner & Peterson, 1980; Vision and Aging, 1981; Elderly Hearing Impaired..., 1981) and their numbers are growing.

MALES, FEMALES AND KNOWLEDGE OF PLACE

There was a wealth of literature and research on the topic of whether males are superior to females with respect to wayfinding capabilities. Some of that literature has demonstrated differences between the sexes (Evans, 1980; Russell & Ward, 1982), but most seem to be due to differences in mobility (parents being more lenient with boys than girls regarding exploration, Siegel & White, 1975; Hart, 1979).

Cross-cultural studies have shown that in Australia and Poland, where sex-biased child rearing differences are minimal, spatial skills and behavior are about equal, whereas in countries such as Mexico boys outperform girls. What are the implications of this as children age through adulthood and into old age? There is so little longitudinal research that the answer is not known.

WHY PEOPLE GET LOST

Researchers have suggested numerous partial explanations for disorientation and for the sensation that one is lost.

Kozlowski & Bryant (1977) studied self-reports of people regarding their "sense of direction" and contrasted these with some actual orienting skills. People with a good sense of direction were better than their counterparts in terms of (a) giving and following directions (both written and oral), (b) remembering routes while a passenger in an automobile, and (c) remembering directions to a place.

To what do they attribute the individual differences? They found that better oriented people like to read maps, enjoy giving directions, try to remember landscape details when traveling and when driving like to find new routes and places. Most of the better oriented people also reported having a role model, a person who served as an example of orientational skills. Poorly oriented people reported feeling more anxious when lost than did well oriented ones.

Among some other common reasons suggested for why people get lost are the following:

1. Early life experiences: factors in our early training and later development may influence our abilities despite the design of the physical environment (Siegel & White, 1975; Hart & Moore, 1973).

2. Experience and locomotion: there are suggestions, for example, that whether one drives a car, rides a bus or walks will influence wayfinding skills (Siegel & White, 1975, p. 25; Aust, 1980; Russell & Ward, 1982).

Hiatt and West (1979) were surprised by the high rate of disorientation and directional confusion exhibited by geriatric patients of a hospital relative to other research, until they learned that a policy of the hospital was to keep the people immobilized in chairs in their own rooms (where meals were taken and most activity occurred).

3. Mixing up right-left vs. up-down: much research has documented the fact that most people can keep track of up-down directions far easier than they can right and left directions (Farrell, 1979; Maki, Grandy & Hague, 1979).

Some explain these problems by pointing out that up and down are typically different (Maki et al., 1979), whereas right and left distinctions may seem more like dealing with equal entities. If the body is used as a reference point, up and down would be dissimilar, whereas left and right should be equal.

The significance of this seems to stem from the work of Piaget who believed that children do use their own bodies as a basis for coming to understand directions. Most children seem to learn up and down earlier and with greater ease than right to left.

Recent studies have suggested that right left distinctions become increasingly difficult when labels (language) must be applied (Pezdek & Evans, 1979). That is, one does all right when following left and right through actions but as soon as words are used confusion results.

4. Ways of giving and receiving instructions: Hiatt (1979; 1982) has commented on individual and geographic differences in how older people give and respond to verbal directions. Midwesterners related internal building directions to compass points, north, south, east, west. Easterners had greater difficulty with compass points and used the terminology of "left and right." Where corners were concerned, the language used in cab riding — "near-left, far-right" — seemed more common. She also noted that confined populations are confused by the conflict in terminology between signs, verbal instructions and argot of those more familiar with the space such as long-time staff.

5. Attention span: attention span is a key to understanding both the learning of children and memory of adults (Cohen & Wu, 1980). What was once thought to be global memory disorder is now being looked at in terms of factors which affect the ability to sustain one's concentration on a task or topic.

In the case of orientation, two issues are significant. (1) Is the individual free or otherwise able to focus upon his or her movements, location and route? (2) Are the reference points or landmarks available designed in ways to maximize or draw attention.

From the individual's point of view, many physical factors may influence available attention. The ability to concentrate is physiologically associated with the forebrain and the reticular activating system. Factors such as one's health, mental condition, or the physical environment which produce stress are likely to deflect available attention. This condition is particularly relevant to older people and to individuals with disabling conditions which demand concentration elsewhere.

6. People under stress: Roberts (1978) has conducted interviews with 80 city dwellers (new and native) to learn about factors which contribute to stress and the manifestation of various stressors. The largest number of complaints about stress from these residents related to travel (92% of the participants). Both pedestrians and drivers were concerned about safety at intersections and danger posed by obstacles. Noise was another major stressor affecting 81%.

A commonly noted reaction to stress is general disorientation (Chiriboga & Cutler, 1980; Eisdorfer & Wilkie, 1977). Some of the literature strongly urges the control of noise as a means of controlling stress (Boles & Hayward, 1978; Poulton, 1979; Roberts, 1980; Russell & Ward, 1982). Other studies have cited crowding as a stressor affecting disorientation (Regnier, 1974; Russell & Ward, 1982).

7. Other factors: dizziness and vertigo (Toglia, 1975; Overstall & Isaacs, 1980) may contribute to temporary disorientation and a sense of being lost. Stress, physiological conditions, toxins, and disorders of the heart and circulatory systems may each contribute to vertigo and dizziness.

Any aspect of mobility, body positioning or mental condition which results in a person's perceiving vestibular and tactile information in a less than upright position may also contribute to disorientation (Book & Garling, 1981; Braine, 1978; Pitblado et al., 1980).

CAN ANYTHING BE DONE ABOUT DEFICIENCIES IN WAYFINDING ABILITIES OF THE GENERAL PUBLIC?

In addition to increasing the imageability of reference points or their salience and frequency in the environment, some descriptions have been offered confirming the possibilities of improving orienting skills.

Naming

Evans and Pezdek (1980) have conducted experiments demonstrating that learning can be improved by providing names for places such as buildings. This research was based upon work with models and needs to be repeated in real settings.

Hiatt (1980) summarizes existing research and suggests that orienting skills of older people are improved when simply namable objects are presented. This work was based on institutionalized populations and needs to be confirmed in community settings.

Using Concrete Versus Abstract Information

Some population groups, including older people and younger children, appear to respond more readily to reference points which are concrete (that is, 3-D familiar objects) rather than abstract (that is, graphic symbols, color coding). With aging, there is strong evidence that memory for objects may be superior to that which requires one to conjure up abstract information.

Mapping and Map Reading

There has been a continuous flow of research on mapping, use of maps, and more recently computerized techniques for making, reading, and teaching map use.

Thorndyke (1981) has found that map clutter is a major factor in mistakes in distance estimation. Tversky's research (1981) suggests that people use a mental principle he calls "perceptual alignment" to make places and forms more regular, grid-like and easy to recall. The effect of such "squaring off" as a memory prop is to introduce distortions in distance estimations. Thorndyke recommends that future maps be developed in which consumers activate a computer obtaining just what information they would need. Noyes' (1979) summary of research data on map reading supports Thorndyke's concern over detail.

Garland et al. (1979) have

studied the specifics of subway maps, again noting that excessive detail slows progress and introduces error but that sometimes color coding may help. Their research also demonstrated that college students made an average of six errors per person in map reading, suggesting that the general public needs training in map reading — especially in urban areas. They also commented that most people prefer to use humans as sources of information over maps.

Hart's work on children's mapping skills and play activities offers creative insights on possibilities to captivate this audience and to become more engaged in maps as a source of place knowledge (1979).

The research on the able-bodied population parallels that of visually and otherwise impaired people; that is, mapping is no substitute for actual practice (Blasch et al., 1973).

In fact, the work on orientation and mobility training of visually impaired and multiply handicapped persons is filled with suggestions which might also benefit the general public. For example, Psathas' notions of the types of maps orientation instructors should use ("occasioned map" where selective input is offered, "direction maps" which show a procedure for getting from a specific starting point to a destination) might be useful in a repertoire for a computer-based system. Pick's work (1980a,b) characterizing pattern and shape perception and connecting locomotion with orientation also has implications for mapping and comprehending space. And Blasch and Welsh's taxonomy for training persons with functional mobility limitations is useful in suggesting skills and mapping knowledge needed by more able populations as well (1980).

Moore (1979) and others are unsympathetic to the suggestion that males or females are better (worse) map readers. It appears that the public as a whole has needs in use of such representations. One wonders whether some of the graphics currently used as a basis for computer games might not ultimately improve the map reading skills of the public.

Becoming More Mobile

Most specialists in orientation and mobility will argue that "the orientation comes first, then the mobility" (Blasch & Welsh, 1980; Hill & Blasch, 1980). But the literature of psychology suggests that mobility practice itself, where feasible, may also influence one's sense of awareness about place.

Weissman (1979) has developed some methods for categorizing buildings by shape and has done research on their relative orienting/disorienting qualities. His lines of inquiry suggest that a next step might be to attempt to orient people to particularly complex situations — as well as to influence design professions to overcome the negative effects of some configurations.

Orienting to Different Points of View

Learning may also be improved by helping some children and adults overcome difficulties they have in coping with orientation when their body position changes.

Consider the experience some people have when they emerge from subways or tunnels on one of four street corners. Evans and Pezdek (1980) suggest that learning from maps may limit people to understanding a single point of view or orientation. The same point has been made by mobility specialists who advocate the use of training techniques which improve our knowledge of multiple points of view (Hill & Blasch, 1980).

Actual learning experiences which offer opportunities to perceive the space from different vantage points typically aids understanding and appears to help people generalize to different perspectives.

General Training and Self-Help

Schroth (1981) has conducted research on methods of improving concept attainment in adults aged 50-79. Results indicate that practice combined with informative feedback is a model which is indeed useful to community-dwelling, relatively capable adults. Self-help and self-generated strategies are workable, suggesting that some cognitive deficits may be based on inadequate or negative experiences.

The topic of self-help has been renewed in regard to concerns of the general public (Gartner & Riesman, 1978). More recently, programs have been developed around the needs of adults through old age (Butler et al., 1978). A training package which includes material pertinent to orientation (vision, memory, and hearing) has been developed with older adults in mind (Hiatt, Brieff, Horowitz et al., 1982) and is available through the American Foundation for the Blind.

SPECIAL USERS, SPECIAL NEEDS

User Needs of Blind People

What does a blind individual need, in general, in order to maintain orientation in the environment? Hill and Ponder (1976), both long-time specialists in training on orientation and mobility, suggest three steps of orientation:

1. Where am I?
2. Where is my objective?
3. How do I get there?

The experience of mobility specialists, those who provide training through schools or other rehabilitation centers suggest the following issues as critical to these questions.

Concept Development: Imagining the Building as a Whole

An individual whose primary constraint is blindness needs an overall understanding of the logic of a building or environment. (Material in this section is based on Welsh and Blasch, 1982). This logic must be able to be readily communicated to and by others, for example, "The building is arranged in a series of small modules, like laying blocks end to end." When factors such as building configuration complicate verbal descriptions, orientation will be more difficult. For example, irregularly shaped structures with 50 degree turns and four or five intersecting hallways may be confusing.

Decision Making: Solving the Individual Problems Along a Route

Traveling or moving about involves constant vigilance and decision making. It is the constant attention and variety of decisions which can complicate orientation for people who are blind. Three areas which may complicate mobility are: (1) repetitive routes or indistinguishable elements, (2) inadequate landmarks, and (3) overload cueing.

Repetitive routes and repetitiously laid out neighborhoods may each complicate wayfinding because one must constantly be attentive to more subtle cues in order to make decisions about turns or destinations. For this reason discrete landmarks aid problem solving, allow some diversion of attention to other aspects of mobility, and may speed progress. Often the problem with using landmarks to aid decision making are (1) there are too few, (2) they are sparsely located, (3) they are not discernible or are difficult for the blind person to locate, and (4) they are not permanent or dependable (such as a portable street vendor's stand).

When there are too many choices or the differences between the signals emitted by the choices are slight (such as sound cues which might resonate from doorways or alleys), the person who is blind may also have difficulties discriminating.

Often these decision making difficulties can be eased if a choice may be validated. For example, if a person can turn and receive reinforcing information from a landmark or sign, then orientation may be simplified.

Using Sequential Versus Simultaneously Presented Cues

A person who is blind tends to rely on a number of tactile cues ranging from the contours of the ground surface and air qualities to sensations of sound and their changes. Difficulties are posed when several cues are presented at once. To apply this concept to design, one would separate or space certain landmarks such as rails, textured flooring or even sound resources.

Maximizing the Memory Requirements

Research on human memory function needs to be carefully applied to the tasks of wayfinding. By limiting the amount of information one must store and recall at once (whether given through sources such as tactile or audio maps or oral instructions) the prospect of relying on one's memory becomes easier. Using information reducing techniques, mnemonic devices, and concrete cues rather than more abstract ideas may all improve orientational processes. At a minimum, reducing unnecessary or redundant information will also alleviate recall problems.

Knowledge of Turns

Successful responses to corners or turns involves anticipation and practice. Cratty (1967) and others (Hill & Blasch, 1980) have described the specific difficulties experienced by blind individuals in recognizing or discriminating between right and left turns. As with the sighted population, people with visual impairments can typically detect an incline or decline as slight as one degree. Some educational techniques have been developed for training individuals to detect turns such as locating grasslines, shorelines or other edges (Hill & Ponder, 1976). The implication for environmental planning relates to the importance of using landmarks to emphasize contours as a means of assisting people with sight limitations.

Gathering Information on Distances

Suppose the visually impaired individual needs to traverse an open field, park, or other area of land, how will he or she move toward a specific target or destination?

The person who is blind often relies on sounds and, sometimes, odors in these situations. Each of these cues has its limitations;

each is often widely diffused in open spaces, particularly odors which are difficult to localize.

Inside a building or expansive court special information provided in advance in the form of maps or oral instructions may be useful. Typically the problem for the blind person is anticipating that such information will be needed and then finding a fixed source.

What Happens When Information is Out of Context?

The unexpected poses challenges to a blind traveler. Teachers of visually impaired people have generated lists of the types of environmental features which are perceived as unexpected by blind people. These include low branches; protruding drinking fountains; fire equipment or telephones; construction scaffolding and unenclosed stairwells (Guidelines, 1977). Because these items are vertical they are often overlooked on architectural floor plans and during early review phases of project development.

Unexpected environmental features may also include curb cuts which flow into traffic without warning, uneven ground, changing levels, sudden drop-offs (pot holes), and ramps or steps without handrails (Guidelines, 1977; Aiello & Steinfeld, 1979; Wardell, 1980).

A third source of unpleasant surprises results from changing configurations or moving landmarks. The practice of putting up temporary barriers on sidewalks or at intersections may create a hazard. Other hazards are posed by excavations, roped-off areas, and low marker stakes used to signal an underground power source or freshly planted grass.

Because the mobility technique of a visually impaired person does become habitual, the person may be careless and fail to detect some of the hazards described previously. It is not unusual for blind and partially sighted people to negotiate their most familiar indoor and outdoor environments without the use of canes, guide dogs or other devices. Consequently, onlookers may not be aware of their needs or may be ignorant of the threat that changed configurations or moved landmarks can pose.

The Hazards and Confusion Posed by Crowding and Restricted Pathways

Disorientation may result from being pushed about in a crowd. Recovery for a person who is blind may be especially difficult. Crowds often have the effect of masking or changing the signals that typically emanate from landmarks including noise and air flow. There are also indications that crowds are stressful, perhaps limiting attention and promoting forgetfulness.

Restricted pathways can also be disconcerting. A person who uses a long cane technique typically relies on information obtained by the swinging motion and touch of the cane. Whether through the narrowness of a path or the presence of many other individuals, such techniques are confounded.

Travel in Adverse or Inclement Weather

Snow may be particularly taxing for the visually impaired and blind pedestrian. The edges of sidewalks, streets, and other property may be less distinct, making routing, turning and locating other familiar ground-level landmarks more complicated (Welsh & Winer, 1976). Grass may harden, becoming indistinguishable from walkways. Ice and icy patches are hazardous. Snow for the visually impaired individual is much like fog for the sighted traveler.

Rain and wind may also hinder orientation, masking auditory cues and creating a nuisance in the form of puddles and clogged drains. Being splashed is also a problem for one unable to anticipate the approach of vehicular traffic. Unfortunately, many of the high tech aids which should be helpful are not dependable in adverse weather conditions.

While there is some literature on training techniques for the visually impaired traveler, there is little information on techniques that communities or designers might use to aid mobility and orientation in adverse conditions.

Sources of Design Inspiration

The design suggestions usually available are solutions to some of the problem features mentioned: entrances, vertical movement, pathways and halls, floor coverings and ground cover, elevators and mechanical systems, telephones, drinking fountains, suspended or projecting objects, displays, signage, lighting, and acoustics. For examples, the reader is referred to Braf, 1974; Wardell, 1980; Guidelines, 1977; Duncan et al., 1977; and Genensky, 1980.

USER NEEDS OF PERSONS WITH LOW VISION

The majority of people with sight impairments are not totally blind but are characterized as having "low vision" (Genensky, 1978; Apple, Apple & Blasch, 1980). A legally blind person is described as one whose corrected visual acuity in the better eye does not exceed 20/200, or for whom the maximum diameter of the visual field does not exceed twenty degrees. A person characterized as visually impaired is therefore not totally blind. Low vision refers to having less than perfect sight after having available medical correction. It is a broader definition than legal blindness (Genensky, 1978). Low vision services, a relatively new and growing area in visual rehabilitation, are directed at techniques and technologies for maximizing best correctable vision (Padula, 1982).

What are the functional implications of being identified as a visually impaired person that affect wayfinding? How might design features be used to minimize adverse effects of the pathologies involved? An individual may experience decreased visual acuity, a diminished field of vision, may "see" objects such as floaters, may experience blind spots or may have defective night vision, poor color vision, slowed light-to-dark adaptation, or various combinations of these impairments (Apple, Apple & Blasch, 1980).

Most visually impaired and blind persons are not singularly affected but rather experience multiple impairments in vision, hearing and/or mobility (Kirchner & Peterson, 1980; Berkowitz et al., 1979). Kirchner and Peterson (1980) report that 59% of all noninstitutionalized people with the most severe visual impairments also have other impairments and 65% of these persons are hard of hearing. Data have been collected but not analyzed on the wider audience of people who have a range of less severe vision impairments but, for these people we also anticipate that vision losses are accompanied by losses in abilities such as hearing, speech, and musculoskeletal functions (Berkowitz et al., 1979). Analysis of nationally collected statistics indicate that being multiply impaired "frequently involves having two or more types of impairment besides visual" (p. 42). Combined impairments are more common among older persons. The implications are that devices directed toward the needs of people who are solely vision impaired may overlook the needs of the majority of potential users of a building or street.

Some orientation problems that may result as a consequence of low vision are discussed below.

Location and Use of Signs

A person with one or more functional effects of low vision may be unable to locate, read or use signs in the community. This handicap may affect the ability to maintain orientation and mobility and often increases the time spent traveling. If the person has a good concept of the layout of a building or community and a general understanding of where signs, corners or other landmarks are located, it may be possible to overcome some of the associated disability.

Orientation and mobility training may encourage scanning techniques or other "eccentric" viewing methods to expedite the localization process (Apple, Apple & Blasch, 1980). Once the sign is located some persons with low vision will need to move very close to read it or to use a visual aid in order to discern the information provided.

Both intellectual and visual abilities may determine the ease with which specific signs are read. Such abilities will also dictate how successful one will be in using matching techniques. It is often helpful for these people to have other individuals verify signs or landmarks.

While there is some suggestion in the literature on print legibility that increasing contrast and using simple, distinctive lettering and plain backgrounds may increase the localization and legibility of signs (Badar, 1980; Vanderplas & Vanderplas, 1980; Ralph, 1982), such ideas are not widely confirmed.

Directing Vision to Immediate Travel Surfaces

Visually impaired persons will typically direct their attention to the surface over which they are traveling. By carefully monitoring the ground the individual is more likely to detect changes and less likely to bump into obstacles, to trip or fall, or to miss other irregularities. However, such attentiveness to the footpath may result in one's missing vertical landmarks or other posted routing information. Individuals may adjust by stopping periodically, surveying the environment to assess their whereabouts and contemplating the next action or decision.

Some individuals with low vision use a long cane to obtain information on surfaces, freeing vision for orientational purposes. There are also all manner of optical devices which have been developed and are increasingly being adopted to aid specific sighting of landmarks in the day or night (Clark & Gosnell, 1981). (See page1.34.)

Fluctuations in Vision as a Function of Changes in Light and Weather

Light is central to the maximization of most visually impaired individuals' capabilities. Too little light on a target, object or landmark and it is lost in its background; with too much glare, the same items seem to disappear (Greenlaugh, 1980).

Education of the individual about his/her condition may result in planning to make outdoor trips in the most favorable lighting and weather conditions. However, negotiation of indoor environments can continually be hampered by inadequate light and excessive glare (Pastalan, 1979). And while the individual may overcome some of the problems of visibility by utilizing human information sources, taking advantage of available technologies, or relying on non-visual cues, better quality lighting is likely to maximize independent travel and negotiations.

Riding and Wayfinding

Persons with low vision may have special difficulties identifying landmarks or reading signs while riding in moving vehicles. Riding public transit can be particularly challenging and may require relying on auditory cues or periodically asking others for information.

Crowds and Low Vision

Crowded areas may pose problems to persons with low vision. The visually impaired traveler may be a slower traveler thus breaking the "rhythm" of a fast paced crowd of pedestrians. The individual may unexpectedly stop midstream in order to get necessary information or reconfirm directions. Training sometimes involves altering travel plans to a less congested time or route (Hill & Ponder, 1976). Well-lit visual aids may be helpful in these situations.

Design References

Two new areas of vision-related research with implications for orientation have been advanced in the last decade. Research on contrast sensitivity as a method of understanding the legibility of print and of objects may result in a new way of testing vision as well as planning environments (Sekular & Hutman, 1980; Sicurella, 1977). In the area of design, the direction is for greater attention to the placement and color of objects with respect to their background as a means of improving visibility.

The second topic of research leading to new design possibilities relates to lighting. Much of the research of the sixties and seventies has resulted in information on energy conservation; many designers have been advised to convert, for example, from more expensive incandescent to less expensive fluorescent lamps. However, research related to the use of lighting to improve vision has suggested that fluorescents may pose difficulties in attention span for many low vision users (Greenlaugh, 1978). Only recently have studies been commenced on the lighting needs of older persons and persons with low vision (prior research focused on school-aged children and people in industrial work places).

The newer research, still being conducted, suggests that lighting must be more effectively used as a method of improving legibility of print and of environmental features (Cullinan, 1978, 1980). Standards for lighting have not been developed in the U.S. which adequately respond to the needs of persons with low vision and of elderly people (Cullinan, 1978, 1980; Lehon, 1980). Most lighting research has been conducted on younger people and has excluded populations with minor to severe vision impairments (Berkowitz et al., 1979). As a result, many individuals have been inadvertently denied the types of environmental surroundings which would make available wayfinding information useful.

For a series of design recommendations related to improved contrast and lighting in design of both outside areas and building interiors, readers are referred to the works of Genensky (1980); Wardell (1980); Apple, Apple, and Blasch (1980); Windley and Scheidt (1980), and Hiatt (1980).

User Needs of Persons With Color Deficiencies

Congenital color blindness affects about 9% of all males and 2% of all females. Most commonly, difficulties are experienced in the red-green area of perception, rendering these colors varying shades of gray. Some of the physiological conditions associated with color deficits are glaucoma, diabetic retinopathy and arteriosclerotic retinopathy. Often these disorders render blue and yellow unnameable or gray.

Recently, attention has been given to the color deficiencies of older persons. Studies demonstrate that perhaps 48% of those not formerly color deficient will experience minor to severe changes in their abilities to name or identify colors accurately (Andreasen, 1980).

As mentioned previously, the lens of an older person yellows as an apparently normal consequence of aging. Very dark colors — blacks, browns, grays, navy, maroon, dark greens — when placed side-by-side in similar amounts on similarly textured backgrounds and under similar conditions of lighting will be much more difficult to differentiate (Fozard et al., 1977; Hiatt, 1980). Similarly, very light tones — pastels, light green, yellow, beige, off-white, pink, and subtle violets — may all blend and be seen as a similar tone of salmon.

Some designers have attempted to compensate for these color deficiencies by relying on a palette of bright colors to improve visibility. However, more recent research has suggested that brightness, per se, is not the answer. Bright colors of the same general intensity may be just as difficult to distinguish or name as are all light, all dark or even all white items.

The key to effective use of colors for most persons seem to involve greater awareness of color contrast, placing light against dark, or bright against dull. The techniques for measuring color contrast using modified gray scales made of lines spaced at varying distances from each other have not been widely applied to design. Such techniques are still being developed and are not yet standardized, nor are they available to the general public as an aid in planning (Sekular & Hutman, 1980; Mollen, 1982).

Data are not available that indicate that one color is "most" visible for the greatest range of people in all situations. Other environmental factors such as lighting must be specified. Also, the pop psychology which would suggest that color alone influences mood is questionable. (Color reactions are a complex function of the characteristics of the perceiver and of the environment.)

Color deficiencies may be minimized by (1) improving contrast in colors and texture (when two colors are used), (2) improving lighting, and (3) minimizing unnecessarily busy color/pattern changes. Almost any color can be used if lighting, amount, contrast, and texture are appropriate. However, the color may not be accurately named. (It is for this reason that some professionals prefer the term "color deficient" to color blind. First, few people are wholly deficient in their ability to perceive all color;

second, most persons perceive differences but they are on a gray spectrum rather than a hue or tone scale.)

User Needs of Hearing Impaired and Deaf People and Related Communication Disorders

Communication and Aging

Schein and Delk's (1974) study of hearing impaired persons in the U.S. yielded a rate of 6,603 per 100,000.

The authors refer to deafness as a disorder of communication, noting that their research shows that while 60% of the adult population perceives their communication level to be satisfactory, yet only 30% reported that they could rely on speech alone in a store to make a transaction.

Data on communication tend to focus on the workforce, omitting people 65 and over who constitute the overwhelming majority of hearing impaired persons and who typically have not learned sign language or alternative communication techniques (Elderly Hearing..., 1981; Schein & Delk, 1974). Offering an information officer who would sign would only meet the needs of a small segment of hearing impaired persons.

Maurer and Rupp (1979) note that loss of hearing ranks second only to arthritis in conditions that affect older adults. Over half of all persons in the U.S. with bilateral hearing losses are 65 and over (Elderly Hearing Impaired..., 1981).

Presbycusis is the most common communicative problem experienced by older people and the most common auditory disorder in the entire population (Maurer & Rupp, 1979). It involves a degeneration of the hair cells necessary to the interpretation of sounds. There are no known cures and hearing aids often do not satisfy the losses in understanding.

Otosclerosis, another common cause of hearing loss in adults, is an inherited disease of the middle ear. It affects about 10% of the population, about 5% of whom sustain a hearing loss as a result. Otosclerosis may yield tinnitus (a ringing in the ears) or vertigo (problems with balance).

While hearing tests involving perception of pure-tone responses to the so-called speech frequencies of 500, 1000, and 2000 Hz have been accepted as a valid predictor of speech intelligibility under "normal" conditions, understanding for the person with presbycusis may be hindered because normal conditions are not typically optimal (Maurer & Rupp, 1979, p. 19). This may result in the common complaint, "I can hear, but I cannot understand."

Older persons lose sensitivity in the upper hearing range (which is used to hear sounds such as consonants, door bells, and audible alarms) and often cannot accept messages delivered at the "normal rate" of 160 words per minute. Tests of hearing in actual daily environments indicate that with an average hearing ability of sounds at 65 dBA, 50% of the elderly in one study rated their ability to hear as fair or poor (Maurer & Rupp, 1979).

Environmental Functioning

In environmental transactions the person with hearing impairments may be affected in terms of:

1. use of auditory instructions (some may not understand verbal instructions because of a general loss of hearing; more have difficulties with public address);

2. signals (for fire, time bells, emergency buzzers);

3. concentration (given that most hearing impaired persons retain some partial hearing, the

problems of background or ambient noise may affect attention and memory; Corso, 1982).

Modifications to the Environment

While research on the environmental aspects of blindness and visual impairment is fairly well developed (perhaps because of the professional interest of orientation and mobility instructors), the literature on environmental aspects of hearing impairments is woefully lacking.

1. Reduction of acoustical sources of stress by minimizing background noise seems to be the first suggestion of those who have researched the majority of hearing impairments (Corso, 1982; Improving the Deaf Person's Environment, 1980). However, certain individuals, such as those with otosclerosis, actually benefit from some "white noise" though they are in the minority of hearing impaired persons (Wiener, 1980).

2. Eliminating unnecessary sources of background noises at nodes (entries and decision points), crowded areas, and intersections may also aid wayfinding techniques. Such considerations are particularly important to older and multiply impaired, hearing impaired individuals (Corso, 1980; Wiener, 1980).

3. Controlling white noise, spillover conversations and other sudden sounds may benefit people utilizing their memories in wayfinding tasks (Maurer & Rupp, 1979; Layton, 1975; "Technics: Office Acoustics," 1979).

4. Muffling, baffling and absorbing ambient noise through the use of fire resistant and textured or sound absorbent surfaces on walls (as well as ceiling or floors) may baffle echos and maximize the intelligibility of conversations (Fozard, 1981; Corso, 1982; Maurer & Rupp, 1979).

User Needs of Persons with Developmental Disabilities

No one developmentally disabled person will exhibit all the characteristics cited, nor do the characteristics describe all developmentally disabled individuals. Such caveats become particularly significant as we restate the recent federal definition.

Developmental disabilities are defined as: "A severe chronic disability of a person which; (a) is attributable to a mental or physical impairment or combination of mental and physical impairments; (b) is manifested before the person attains age twenty-two; (c) is likely to continue indefinitely; (d) results in three or more of the following areas of major life activity: (i) self-care; (ii) receptive and expressive language; (iii) learning; (iv) mobility; (v) self-direction; (vi) capacity for independent living; (vii) economic self-sufficiency; and (e) reflects the person's need for a combination and sequence of special, interdisciplinary, or generic care, treatment, or other services which are of lifelong or extended duration and are individually planned and coordinated." (P.L. 95-602, 1978)

While this definition includes many disability conditions, probably the most prevalent is mental retardation. For many mentally retarded individuals restricted environments and overprotective social situations become concomitant conditions to contend with. The individual also becomes very dependent upon others for mobility and may fail to adequately develop environmental concepts.

Signs

Reading difficulties may restrict independent travel. Significant deviations from familiar or standardized signs may pose difficulties. Sometimes abstract terminology is not meaningful, such as esoteric pictographs or foreign words for restroom signs. Clutter or too much information presented on a panel can also cause problems. When the individual is required to respond rapidly and has a great deal to read or absorb, confusion may result. The individual needs time to interpret information, react, and then make decisions. (See Templer et al., 1982.)

Environmental information including landmarks, maps, and signage, must be clear, distinct and obvious. Periodic reinforcement that one is on the right track or path is important and can be accomplished through repeated signage or information centers.

Despite the need for simple, concrete signs, and the minimization of unfamiliar symbols, environments for mentally retarded or developmentally disabled persons need not appear sterile.

Right Angle Turns and Paths

Some persons with developmental disabilities or mental retardation may have problems when rooms or buildings do not follow a straight, linear path.

The individual may not only have some problems in learning the way around a non-linear environment, but once a route is learned it may become very building specific. Some persons who are mentally retarded have difficulties generalizing from one space, route or pattern of turns to other environments.

In sum, knowing that signs are available, providing grid or linear plans, and offering environmental cues may all serve the orienting needs of developmentally disabled persons.

USER NEEDS OF PERSONS WITH LEARNING DISABILITIES

A person with a learning disability is basically defined as a person with average or above average I.Q. who has difficulties learning due to one or more of the basic psychological processes involved in understanding or in using language -- spoken or written — which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations. The term includes minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation or emotional disturbance, or of environmental, cultural, or economic disadvantage (Public Law 94-142 s. 121a5[6][9]).

Learning disabled individuals by definition are a very diverse population, and therefore problems with the environment may range from none to very extreme.

Uniformity of Spatial Layout

The person with learning disabilities typically has problems orienting to places which lack uniformity or which are laid out in non-logical (often non-linear) patterns.

This situation can be created by providing too many confusing stimuli (Hallanhan & Kauffinan, 1976), such as abstract indicators of direction and complex numbering systems. An example of a confusing numbering system would be wings labeled A, AA, B, BB, etc.

Aisles of stores which form

mazes, cluttered counters and disorganzed display units may all perplex the person with learning disabilities. Some store and hotel chains have one layout regardless of geographic store location for aisles and even counters and goods. These buildings may be more effectively generalized and negotiated by many learning disabled people.

Slight Turns

Slight turns of 30 degrees to 50 degrees may pose more difficulty than do 90 degree turns. Blasch (1982, personal communication) has studied a hospital where the layout is based upon ten nested diamonds in two parallel rows of five each. Where the modules connect, there is a foyer; the person must select from among two to six doors. One is unable to walk a straight line between a series of modules and is constantly required to make turns. The environment has been particularly confusing for people with learning disabilities to negotiate.

Making Instantaneous Decisions

Persons with learning disabilities are at a disadvantage when attempting to make quick decisions (Haring & Bateman, 1977) about direction or action. In the hospital example cited previously, choices must be made while a number of other people are passing through. Wayfinding and decision making are confounded in these situations.

Distinctive Cues and Landmarks

The limited research available indicates that discrete cues or landmarks (Farnham-Diggory, 1978) such as simple outline pictures or maps can be useful for this population.

SPACES AND ELEMENTS

General Considerations for Spaces and the General Population

Numerous models have been proposed regarding how architectural and natural elements in the environment influence human understanding of spaces and abilities to negotiate them.

Lynch (1960) proposes seven elements of a city image: paths, edges, districts, nodes and junctions, landmarks, element interrelations and image quality. Together these elements give one a concept of the space as a whole. Magana (1978) has found some research evidence that these concepts are indeed useful to city dwellers. However, while the elements are widely cited in design recommendations (Windley & Scheidt, 1980), there is confusion regarding the relative merits of each, the potential for substituting one for the other, or the best means of providing each (Rapoport, 1976; Russell & Ward, 1982).

Building Layout

Spaces and elements appear to have significant meaning to wayfinding skills of the special users and age groups described.

One technique for providing an overall understanding of space involves making comparisons with other known spaces and shapes. Weisman's (1979) work in identifying a range of possible building configurations may be especially helpful in providing a taxonomy of spaces and ways of identifying them. It is easy to describe the geographic outline of Italy once one recognizes the idea of a high heeled boot.

Orientation to the inside of buildings would similarly be aided were some overlying principles available. Identifying prototypical spatial configurations of hallways and even roads and routes would be useful to visually impaired persons, and might also benefit members of the developmentally disabled and elderly population.

An understanding of the uses of prototypical layouts may also provide information on people's ability to relate specific configurations to probable orienting/disorienting problems. For example, round buildings, H-shaped facilities, and L- shaped settings may each pose particular problems in linear travel. It would be helpful to be able to translate building form into information on orientational needs. Certain building configurations, for example, are confusing with respect to where entries are located. ("Which door is the 'real' entrance?") Lawton (1975) cites this as a problem in housing for older people and suggests that these types of dilemmas could be resolved with more specific signage.

Signage and directions need to be considered in relation to spatial layout. Some layouts may require more or different cues than others. Signs have become more important as layouts become increasingly complex or unfamiliar.

Circulation Areas and Egress Paths

Circulation and the General Population

Siegel and White (1975) distinguish between the significance of circulation areas or routes and of landmarks in the orientation of the adult population in general. Routes are predominantly sensorimotor and not visual. "Route knowledge is to some extent sequence knowledge. [Routes] represent habitual lines of movement and familiar lines of travel" (p. 24). Adults may develop their knowledge of circulation routes through both formal means (looking at maps or trying to be mobile) or by incidentally obtaining such information.

Route and Hallway Knowledge

General Public. Less work has been done on the imageability of routes and hallways themselves than on the topic of landmarks, vistas, and other singular elements. Perhaps this is because methods such as still photography have lent themselves to study of localized views and objects. Data are not reported on how often signs are needed in roadways and hallways.

If greater attention were applied to route knowledge, overall orientation would improve and people would be less reliant on small and elusive signs to show direction, paths and the like.

Special Users. Route knowledge is being formally taught to most blind and visually impaired persons participating in orientation and mobility training (Hill & Blasch, 1980). However, those who experience impairments late in life or who do not have access to special training or orientation and mobility instruction are not getting similar insights. Again, the group of people is predominantly elderly. There are few programs for developmentally disabled persons on route training (see Hiatt et al., 1982; Stevens, 1980; Uslan, 1976).

Techniques ranging from simple tactile mapping and fairly fast audiomapping (Blasch et al., 1977; Bentzen, 1980) are aids for visually impaired users. Similar orientation aids are needed for other handicapped individuals.

Risks

Risks may vary according to two types of users; (l) habitual travelers of an area who may be less alert to its features, travelling in a "daydreaming" fashion, and (2) those for whom features of the area pose such potential risks or hazards that they may become the focus of all attention.

The familiar user is at risk because of his or her inattentiveness. This may be especially true of visually impaired users encountering hazards along a route.

It is interesting that so few of the building codes (See page 1.44) deal with risks along routes. It is not required, for example, to indicate to a wheelchair user which routes will take him or her through a building or from a room to an accessible exit. It is not required in most states studied that hazards or temporary changes from a route be carefully signified for the visually impaired user. While highway signage is expected to direct travelers through construction sites via alternate routes or to show special truck routes for commercial vehicles, there is no indoor counterpart.

Changes or hazards may be especially challenging for the developmentally disabled traveler who learns, perhaps by rote, a single bus route, subway routine or even walk from home to school.

For the totally deaf person notification regarding fire or emergency evacuation is needed, particularly for workers or residents of apartments who may be alone. Similarly, systems are needed for communicating with visually and hearing impaired persons not only about the need to evacuate (which might be done through tactile or lighted signals), but also about an appropriate route to take out.

Minimizing Confusing Choices

Confusion over routes results from numerous factors: the nature of the circulation path itself, the lack of ability to see ahead, the amount of stimulation along the way, and the means of transport.

Human variables or factors which diminish one's ability to look ahead include lighting, glare, posture, gait, or neck flexibility (affecting older people and certain disabled individuals), visual acuity, weather conditions, crowding and stress.

The literature on the difficulties in left-right orientation has not been translated into the design of circulation routes.

Building interiors and highways offer examples of confusion over route markings. A numbered highway may suddenly be signified as a named road (90 vs. "Calumet"). The "north corridor" may take on some local neologism such as "rehab wing" which is never reported on signs. Some effort to personalize signs is needed. For example, wording on signs should reflect local usage. Signs must also consider the needs of both the occasional and familiar traveler.

Decision Nodes

The issues in planning decision nodes include:

1. What decisions do they demand?

2. How quickly must one respond?

3. What stressful factors are present to limit decision (glare, crowding, noise)?

4. What familiarity is available? (Are nodes at right angles fairly

simple to grasp through vision and/or hearing and/or common experience, or do many routes intersect at a point?)

5. What happens if one makes the wrong choice?

6. What happens to reinforce or check the choice made?

Though the elements used to ease decisions may vary from one user group to another, in general allowing some space between the presentation of information and dangerous or stressful features of the setting will aid the traveler.

For the physically handicapped user the questions may be: If I make a choice at this node, can I carry it through? Will I be able to turn around and get out of this bathroom once I let the door go?

Rooms and Spaces

States also vary greatly in their commitment to the importance of labeling rooms and spaces as evidenced by their rules. (See Appendix B.) There seems to be little agreement on what rooms should be labeled. At present, elevators are far more likely to be designated than are bathrooms if one were to use the rules as the only indicator. (See Table 1.)

Two issues are significant to wayfinding: (1) "what spaces or places need identification and (2) "where" should such identification be placed. Currently, the controversy rages over whether the latch or hinge side, right or left should be used. (See Woods, 1983).

In residences for older persons there has been a continual plea for signs next to the door, for indicators which are within eye level, and for linear identification. Room and space identification usually involves a sign. However, some research on aging suggests that actual views into a place are very helpful. This type of information might be offered as a supplement to aid designers seeking some alternatives to signs. There are different points of view on such window openings because there are many consumers and educators/professionals who perceive viewing as an invasion of privacy. However, signs alone do not guarantee room identification.

Signage and the General Population

It is indeed interesting to note how little is known about signage for the general population. In Overview of the Impact of Building Code Regulations, in the context of the Rule Review, some specifics related to signage have been identified for general populations as well as for special users.

To preview some of the more salient general issues:

1. Is the graphic form that signs take important? Are printed signs and graphic illustrations equally useful or more useful for certain spaces than others? It is hypothesized that when the majority of the public is familiar with the purposes of a space (toilet room), the symbols are probably acceptable. However, data are not available on the user needs of developmentally disabled people in this regard. Problems arise when the symbol is abstract and the purpose it labels is unfamiliar to the potential user.

2. Print legibility is a topic of interest to all consumers. There is some literature which suggests that text is more readable in serif styles while gothic type is more readable for building signs. Print and type have not been studied with

respect to the background used in signs as well as in relation to light, texture, color and size (Vanderplas & Vanderplas, 1979).

Seriph for printed matter.

Sans Seriph for signs.

Signage and Special Needs

Research has not adequately resolved questions on the use of tactile graphics for disabled persons. Literature on recessed versus raised lettering is particularly contradictory (see page 1.44). Existing codes suggest a preference for raised letters. There are strong convictions that recessed lettering or numerals cannot be detected by blind persons with arthritis (Wardell, 1980). Could it be that incised letters are not sufficiently recessed or wide enough to allow detection? Variations in recessing or raising have not been studied or reported for a full range of handicapped persons. Raised letters shadow; they may create a distortion where "3" looks like "8". But it is possible that lighting or placement overcomes the problems of shadowing.

Perhaps more attention ought to be paid to the placement of tactile graphics. One group of designers suggested that they be used on handrails (Cotler & DeGraff, 1976, p. 37), but did not discuss the effects of tactile variation on those who need to slide along the rail. Handrails in stairwells would seem particularly important to mark unless research demonstrates that the concerns should be broadened to corridor rails as well.

Symbols and signs for other than wheelchair users are minimal. Representatives of the deaf community have suggested that a hearing access symbol be devised to denote settings adopted to these users' needs.

Even the access symbol has been criticized recently. Is the blue-colored subject too faded?

ACCESS SYMBOL
Dark on light

ACCESS SYMBOL
Light on dark

Is it visible to older persons or those who have visual deficits?

How about contrast? If it is a good idea in terms of color, how should it be measured. (See discussion in Appendix C related to questions raised by the ATBCB.)

With all of the emphasis on signs, there was relatively little literature to support the strength of commitment to its use.

Landmarks and Reference Points

The term "reference points" has been suggested as an alternative to "landmarks." Reference points are those places whose locations are relatively better known and which serve to define the location of adjacent points (Sadella, Burroughs & Staplin, 1980, p. 516). Reference points may include features of the terrain which are not typically included in discussions of landmarks as well as referring to the imageability or symbolism of these features.

A laboratory study of 50 college students indicated that six types of information were useful in referencing:

1. size: dimensions such as large/small, tall/short, dominant/dominated, and high/low economic significance;

2. familiarity: whether used often/rarely, location well-known/poorly-known; familiar/unfamiliar;

3. cultural value: high cultural identification/low cultural identification, and good/poor aesthetics;

4. form quality: simple/complex, inexpensive/expensive, repair (good/poor), and age (new/old);

5. marker salience: well/poorly labeled, near center/near border;

6. visual salience: off/on the path, visible/not visible.

Sadella, Burroughs and Staplin (1980) were able to rank the relative helpfulness of the six types of reference points to the population studied. Most helpful were those items related to familiarity, dominance, cultural importance, and nearness to center of the region. Least helpful were items related to newness and visibility from a distance.

The research of Sadella et al. represents one of the first efforts to describe what people actually use rather than continually suggesting reference points or landmarks without determining what is already useful. It needs to be replicated with other age groups in indoor and outdoor real world settings, and with users of a variety of abilities.

The implications for landmarks and reference points are poorly researched. On one hand, Rapoport (1977) asserts on the basis of both theoretical and empirical literature that complex, ambiguous environments challenge individuals to involve themselves. Rich, complex, vivid environments, in his experience, are preferred to uniform, monotonous, or chaotic ones. Rapoport states that the relationship between this and uniformity of signs has not been adequately addressed.

However, neon and bright lights — effective in initially drawing attention — may be difficult to focus on for any length of time, particularly for older people sensitive to glare. Research is needed on what makes some signs and symbols more attention getting and on what contributes to sustained attention (if necessary, as at a traffic light)? The studies on stress suggest that landmarks may be more important in situations where stress is greater. Individuals may therefore rely more on landmarks or reference points and on experience with routes and less upon an overall mapping knowledge of space in environments or situations where attention is limited.

Tactile Materials

Tactile cues may be particularly useful to blind and visually impaired persons. Work is currently underway on their use and effects for the visually impaired and for the population at large (Templer, Lewis & Sanford, 1983).

Changes in pavement information can not only serve as a landmark but also indicate hazards such as stairs and other changes in elevation.

Work at Syracuse University by Steinfeld (1976) and at the Pedestrian Research Laboratory (PRL) by Templer and others (1980) has indicated that there is a range of materials that are potentially detectable to cane users.

Steinfeld (1976) found that texture could be detected on large concrete floor surfaces. Following up on this research, the PRL group found that tennis court surfacing materials are sufficiently varied to be detected by persons of college-age who are blind. Such surfacing materials can, according to Templer, be perceived as different from brushed concrete.

Herms, Elias and Robins (1976) have described successful uses of guidestrips to aid visually impaired pedestrians crossing confusing and complex intersections in San Diego. The guidestrips used consisted of a two-inch wide epoxy cement which had been embedded with a 1/4" thickness of pea gravel. The visually impaired long cane user would touch the strip and follow it across an intersection. Such methods may also benefit partially sighted pedestrians.

Special tile is another method of texturing pavement and can be identified through soft-soled footwear. Tile is used in Japan to guide visually impaired pedestrians to touch posts at intersections. The touch posts are vertical poles and provide additional information about the intersection through vibration and audible signals. Raised studs have also been used as guides along edges of some crossings.

Templer et al. (1982) studied 12 blind cane users' orienting and mobility skills using a series of 32 different panels of unique materials. (See Table 2, Appendix A.) The users were asked how they detected each panel (that is, by sound, by rebound of cane, by texture or by a combination of factors).

Table 2 indicates the primary detection method of each of the tested materials and the recommendations for use.

Those panels most appropriate for locations with very high ambient noise were steel on thermoplastic on concrete; 1/16" neoprene on concrete over cavity; 1/4" thermoplastic on concrete over cavity; 1/4" corrugated plastic on concrete; and 1/16" thermoplastic on concrete. These panels were recommended because they were primarily detected on the basis of texture.

Templer et al. also studied stopping distance and panel size. In this study each subject was asked to stop as soon as a panel was detected and the distance from the subject's feet to the far end of the panel was used as an indicator of how soon a panel was detected. The results indicated that a depth of 42" was necessary for panels to be detected by virtually all subjects.

Templer et al. state that a panel that is 24" deep "will provide sufficient early warning to 85% of the users and should therefore be adequate."

A study of a subsample of low vision users was undertaken to determine the applicability of findings. Due to the fact that between 80-90% of the legally blind population have some residual vision, a test of visual contrast was set up. The people were tested twice — before and after the track was painted.

The results indicated that painting the panels in any of the two color combinations used in the study (and where ambient illumination is similar) greatly improved the probability of detection by partially sighted persons. Due to the small sample size, the relative usefulness of specific colorations could not be determined.

Templer and his associates suggest the significance of positive cues. Positive cues are solutions that can be added to reduce the probability of disorientation (for example, the textured strips at a crossing).

These researchers identified several orientational difficulties of visually impaired pedestrians: crossing open spaces and non-perpendicular path intersections; finding the appropriate place to cross a street (especially at a rounded corner); and finding a dirt or graded path.

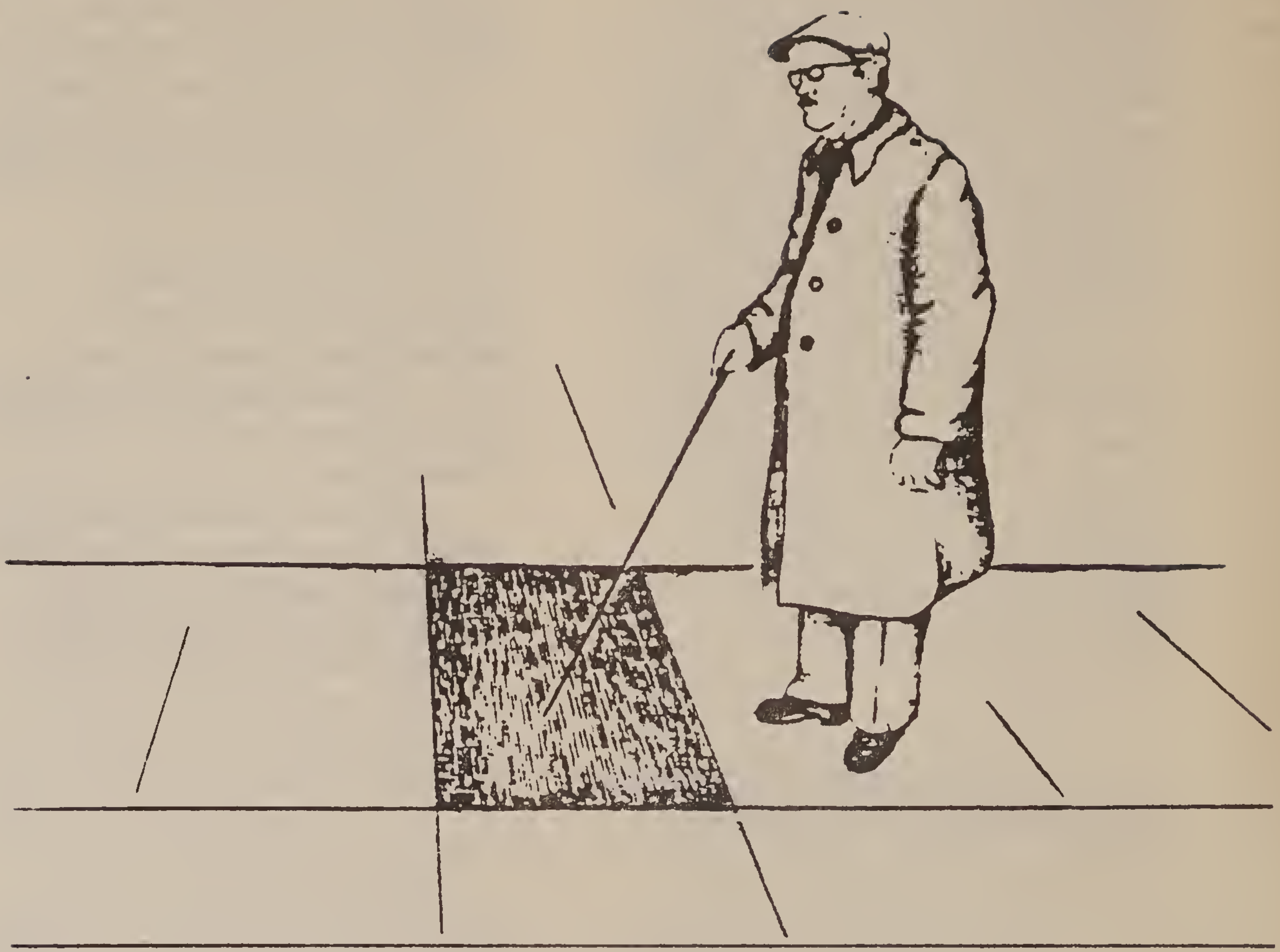
The most to least effective design measures provided were: wooden shoreline, tweeter, metal plate, wooden plate, rubber mat and carpet mat.

VISUALLY IMPAIRED PEDESTRIANS USING COUNTERMEASURES

Wood Chips on Dirt Path

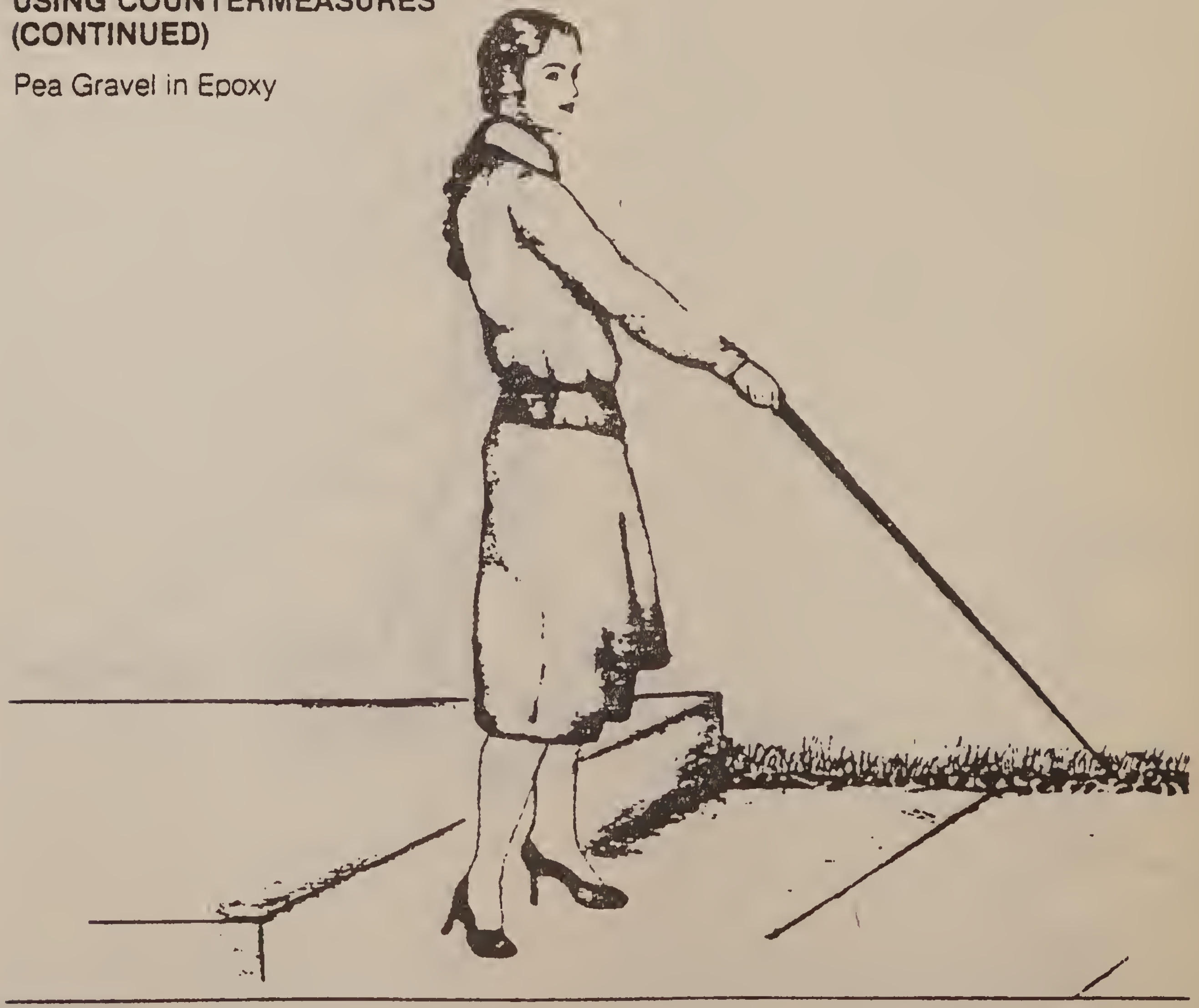
VISUALLY IMPAIRED PEDESTRIANS USING COUNTERMEASURES (CONTINUED)

Carpet Mat



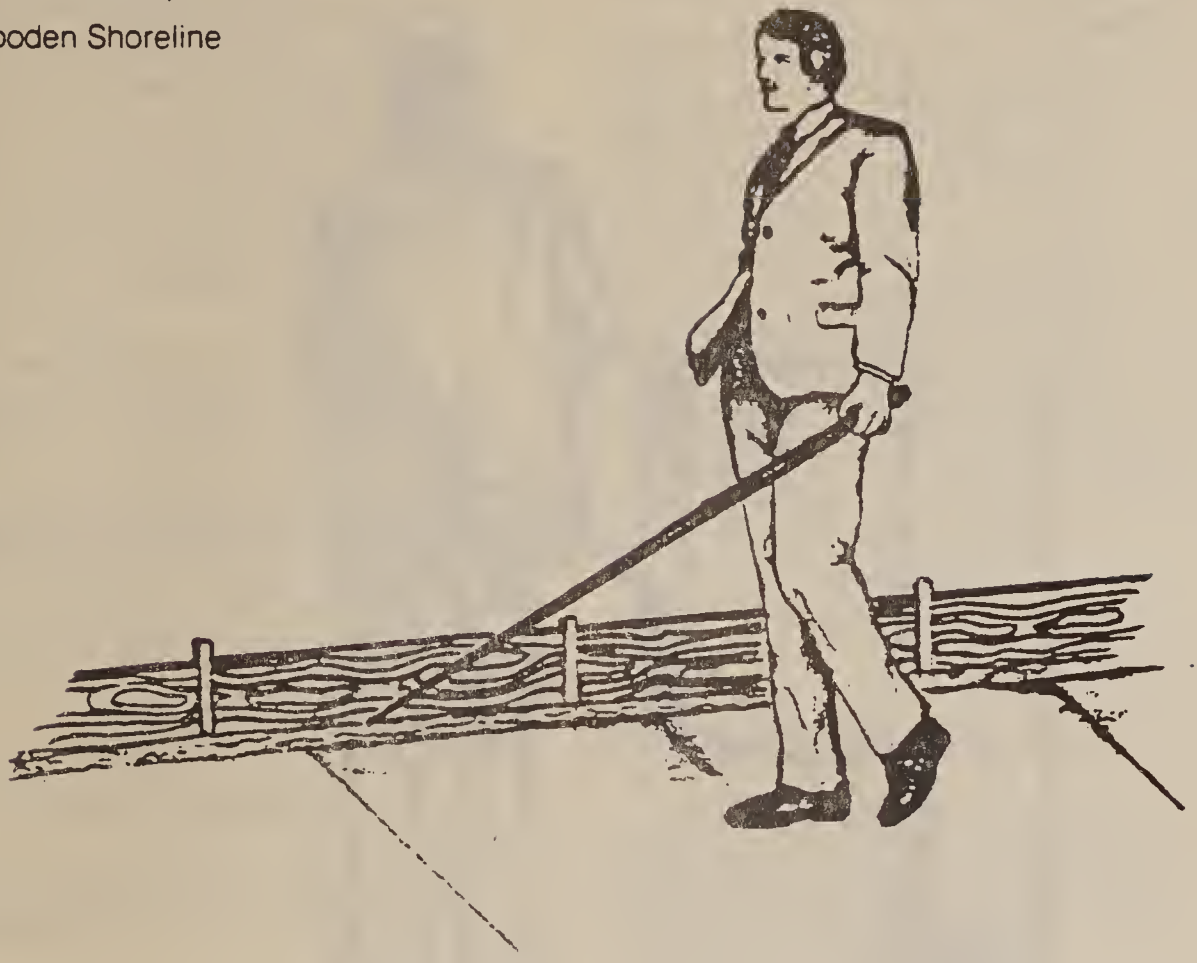
VISUALLY IMPAIRED PEDESTRIANS USING COUNTERMEASURES (CONTINUED)

Pea Gravel in Epoxy



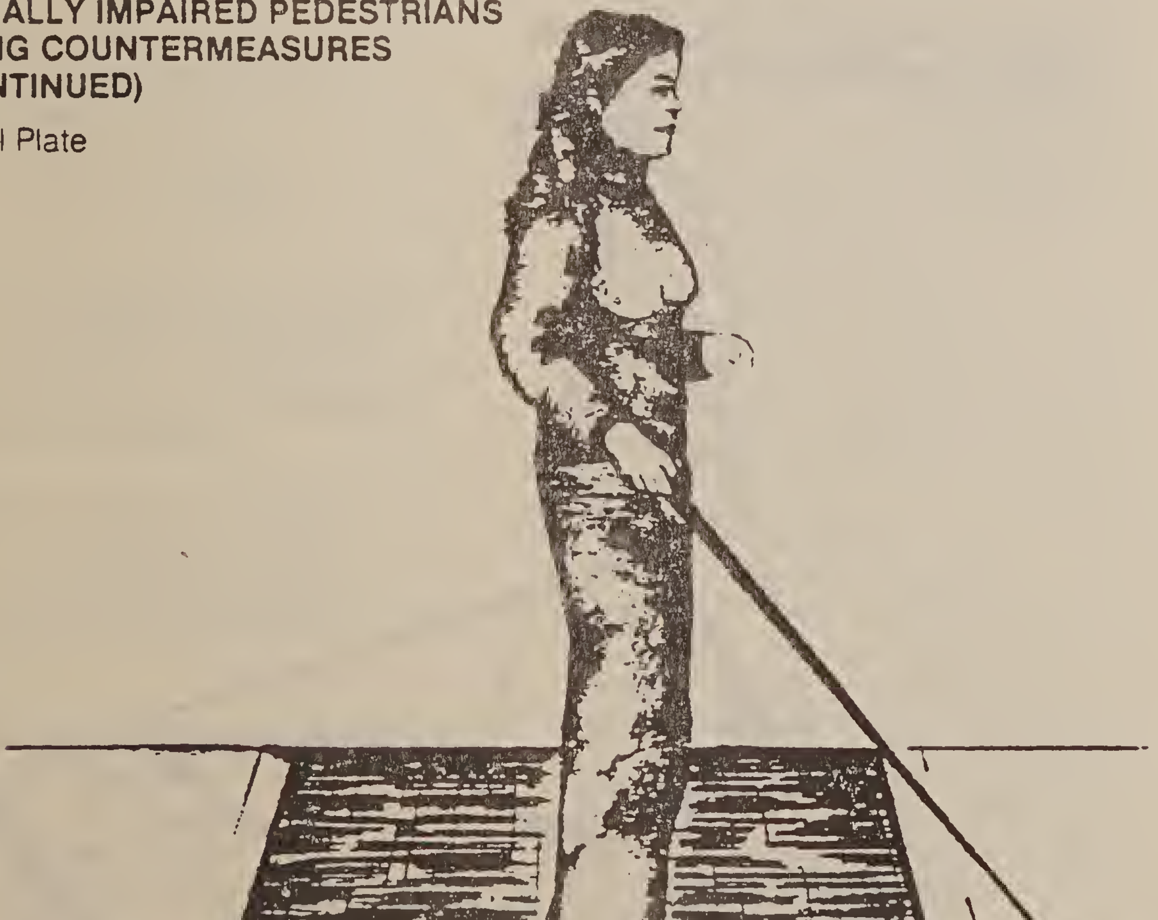
VISUALLY IMPAIRED PEDESTRIANS USING COUNTERMEASURES (CONTINUED)

Wooden Shoreline



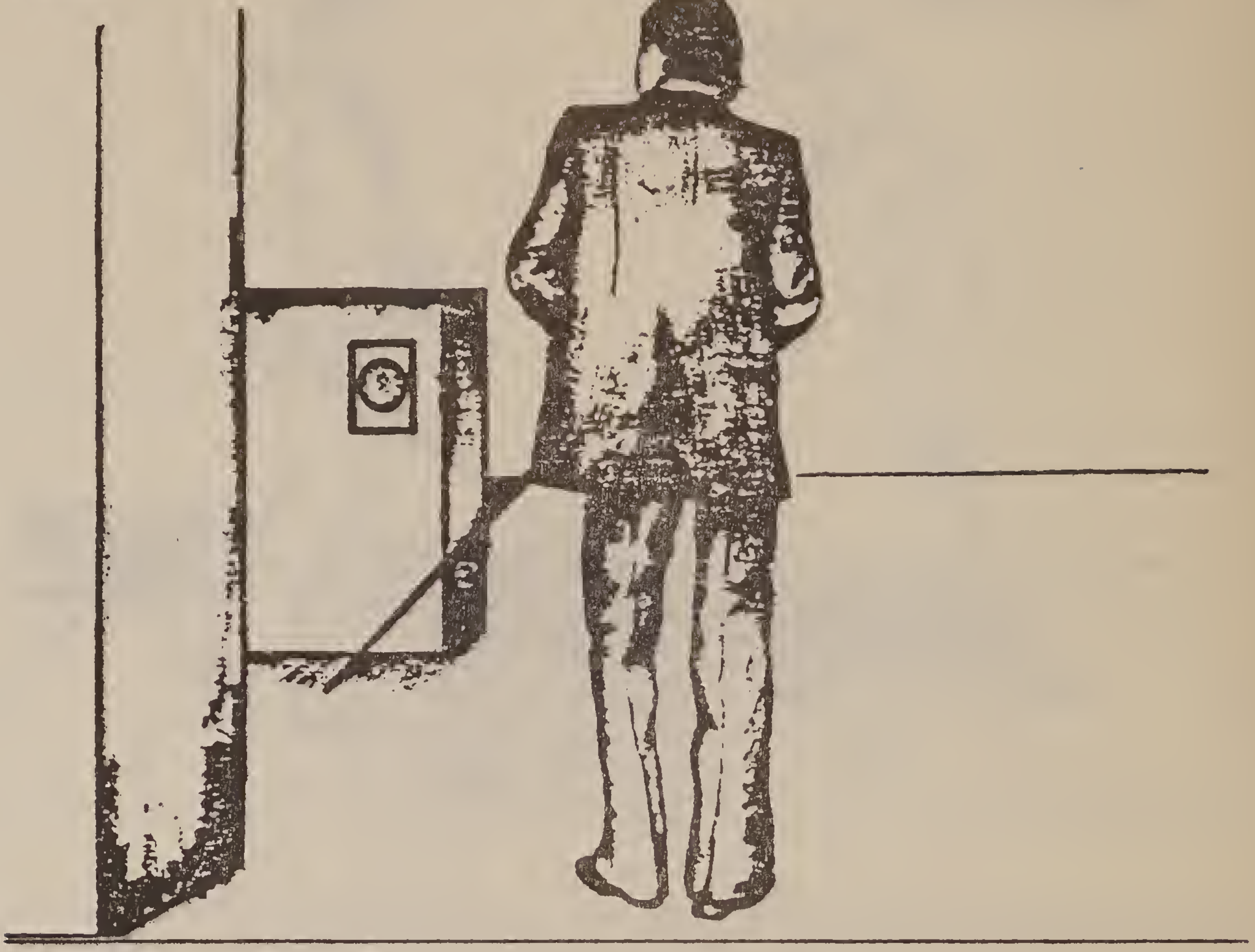
VISUALLY IMPAIRED PEDESTRIANS USING COUNTERMEASURES (CONTINUED)

Metal Plate



VISUALLY IMPAIRED PEDESTRIANS USING COUNTERMEASURES (CONTINUED)

Tweeter



VISUALLY IMPAIRED PEDESTRIANS USING COUNTERMEASURES (CONTINUED)

Rubber Mat

The results support the previous findings that landmarks which produce a loud noise when struck with a cane are helpful as orientation cues. Distinctive rebound, like that of rubber mats or carpet panels, is also helpful. This study was also conducted with a notably small selection of visually impaired pedestrians.

Other design guidelines are suggested throughout the final report of Templer's work. The work is a model, despite limitations in sample size, of how to approach an overall topic area and begin to fill in knowledge gaps in a systematic way.

NEW TECHNOLOGIES

Technologies refer to the following:

1. direct aids for wayfinding, which alleviate or overcome the disability itself.

2. aids that involve the macroenvironment (using for example large scale improvements in transit, architecture or paving);

3. aids that engage the microenvironment, using such means as sensors to control lighting or acoustical resources to announce hazards;

4. Systems that are worn, carried or otherwise made portable and available to individuals who would need them; and

5. Methods that involve the individual, including education and training, or means of conveying information to and from individuals.

Technology for Visually Impaired Persons

Several devices have evolved which present an auditory or tactile output to facilitate wayfinding for the visually impaired person.

Here, examples of "low", "medium" and "high" levels of technology will be reviewed. Low refers to using existing information more effectively; medium refers to taking existing knowledge and with minor adaptations generalizing it more widely; high refers to evolving totally new solutions.

Environmental Technologies

TALKING SIGNS. Talking signs such as those developed at the Smith-Kettlewell Institute of Visual Sciences are one example of signal systems. Talking signs emit sounds or words as a means of giving directions.

Talking signs are based upon the principle of light beam communication. A miniature, low-powered, infrared light transmitter is placed at locations where written signs would conventionally appear: street signs, bus stops, information desks, exits, etc. A small signal can be picked up by a specially designed receiver carried by the visually impaired person. The receiver picks up the infrared light source, decodes the sign, amplifies it and "speaks" the message. The cost of the talking signs is relatively low, approximately $75.00 per sign and $150.00 per receiver. This system is being used in the Smith-Kettlewell Institute but they have not been tested extensively in other environments and by a full range of impaired users.

Orientational and Navigation Devices. SONA (Sonic Orientation and Navigational

Aid) is another high technology item which interacts between user and environment. In development at the Georgia Institute of Technology, this device consists of a digital radio receiver and an audio tone generator which serves to orient the user.

The technology is basically the same as that used in an automatic garage door opener. Receivers can be mounted in a variety of locations, such as at landmarks or decision nodes like exits, telephones, and elevators. Each location can be assigned a three-digit code such as 835 for a men's restroom or 227 for the women's restroom. A visually impaired traveler would carry a transmitter (5" x 2 1/2" x 2") with a touchtone keypad to transmit a designated code. Each transmission (for example, 227) elicits an audio response from that receiver with that specific code (such as women's restroom). Users would localize the sound using their own hearing abilities and locate the target area.

This prototype device is unique because unlike many existing aids (see following), the user commands the information desired and is not bombarded by constant, uncalled for signals.

The SONA is expected to sell at $50.00 for transmitters and $40.00 for receivers. The device is now undergoing some limited field testing.

Auditory Marking. The Sound Beacon, also being developed by Smith-Kettlewill Institute is an auditory marking device. The visually impaired user may place the Sound Beacon at a designated location. A small, battery operated, self-contained unit emits periodic bursts of tone. The volume, pitch and rate of bursts can be adjusted by the user to suit specific situations.

A similar device, the Auditory Beacon developed by Torben Poulsen at the Danish Technical University, automatically compensates for ambient noise and continuously produces a 900 Hz signal at a level 10-15 dB louder than ambient noise. While the cost of the Sound Beacon is low (approximately $20), the interest and field testing of this device has been limited.

Street Crossing Signals. Another area of wayfinding technology involves audible street crossing devices. These devices are either automatic or pedestrian activated. Placed at street corners where crosswalk signs are located, audible signs alert visually impaired persons when the traffic light has changed to a walk signal.

The automatic, audible signals are activated by the cycle change in traffic lights. The signals are generally high-pitched tones (which may be a problem for older or presbycusis-diagnosed, hearing impaired persons). The tone will increase in volume with a rise in ambient noise in the vicinity.

One system, manufactured by Nagoya Electric Works of Japan, produces bird-like noises. Systems used in Germany emanate a variety of sounds, a different sound pattern on each of four corners. However, most systems give off a buzz or whistle.

The pedestrian-activated crossing devices are switched on by a crosswalk button. When the light changes to green, the buzzer sounds.

There is still a question of the usefulness and desirability of such devices for visually and hearing impaired persons. The knowledge necessary to design these systems is available but the value has not yet been determined.

Aids and Guides Worn or Carried by the User

Four techniques for orientation

and wayfinding are outlined here. The information provided is based upon a booklet published by the American Foundation for the Blind (Mellor, 1981). Published reports on the testing of these for special users other than blind persons are minimal. None of these devices is widely used at the present time. The American Foundation for the Blind is currently engaged in a study of several items for multiply impaired, mentally retarded individuals and for older people (Uslan, 1982).

The Russell Pathsounder is a simple box that sends out ultrasound beams to detect objects directly in front of the user who might be visually impaired and in a wheelchair. A low-pitched sound is the reflected ultrasound beams from objects three to six feet away. The device could also be used by deaf-blind persons through the aid of tactile stimulation of the neck strap. When the device is not signaling, it serves to indicate an absence of objects. This could also be used to indicate doorways or openings. The device has been cited for its simplicity and ease of use. The level of information given is criticized for being too simple. Problems are also posed when the wearer has bulky clothing.

The Laser Cane is an adaptation of the most widely used and familiar "long cane" for blind and visually impaired people. The long cane has been criticized as an orientation and mobility device because: (1) it requires direct contact with a surface or object; (2) it can not detect overhanging objects such as phone boxes, wall mounted water fountains or tree branches.

The laser cane compensates for some of these limitations. The laser cane emits three narrow beams of infrared light. The straight ahead beam transmits a signal about 9" above the ground and detects objects from 5' to 12' away. When an object is detected a pin located on the cane about where the index finger would fall vibrates. For persons who cannot detect the vibration or who must wear gloves, a sound may be emitted. An upward beam detects obstacles from about 27" - 30" above the ground to head height and gives off a higher pitched beep through a speaker in the cane's crook. The third beam detects drop-offs deeper than 5" at a distance of about 3' and a low tone is emitted from the cane's crook. The cane has been used to confirm landmarks. The device requires some range of motion in the arm and a steady swinging technique which might limit its utility for certain users. The cane uses batteries; if these fail, it can be used as a conventional long cane with the mobility techniques.

The cane may not register plate glass. The beam passes through glass and would not signal it as an obstacle, especially if the glass is clean (the beam would be stopped by dirt or even finger prints). Glaring or shiny objects will also trigger the warning signal prematurely, distorting information on nearness of the obstacle.

The Sonicguide (TM) provides three kinds of information about environmental objects: direction, distance, and surface characteristics. However, the device is not used alone but in conjunction with either a long cane or dog guide. A box the size of a pocket radio or camera is worn on one side and the user wears glasses in which the receivers are located. The glasses have small ear tubes, through which the wearer hears the sounds. The Guide works by providing the wearer with stereoscopic signals, for example objects on the left are signalled louder to the left ear. Pitch is the indicator of distance — the lower the sound, the nearer the object. Its effective range is from 0' - 5' feet away, from ground to head height and 30 degrees to each side. Textural changes will result in changing sound tones, requiring the user to develop a taxonomy for understanding of the textural properties of the environment. The device has been used in mobility training by persons with some residual (low) vision and to orient infants and congenitally blind children to spatial characteristics of the environment. After learning a route, use of the Sonicguide (TM) is frequently discontinued. Its limitations may include the need for fairly acute hearing since the majority of visually impaired people are also hearing impaired [Kirchner & Peterson, 1980]). Difficulties are posed for hearing impaired persons who must learn the meaning of its many sounds. Sensory overload can result from the amount of information the Sonicguide provides. It does not detect steps, curbs or other drop-offs, thus often requiring the use of dog or cane. Some people may find that the ear tubes block out conventional environmental sounds (conversations) which are also necessary to orientation and mobility.

The fourth device type is a Mowat Sensor. This too is a small box-like device. It emits a narrow signal and detects objects from three to thirteen feet away. The sensor, located in the device itself, picks up reflected ultrasound waves and causes the box to vibrate when obstacles are detected. The device is typically used in conjunction with a dog guide or cane. Advantages might include its compactness, simplicity, and lack of reliance on audition. However, holding it may be inconvenient while also using another device.

Technologies and Map Making

In the past few years, research and technological improvements for tactile map making and use have increased. Currently Wolfgang Preiser, Ph.D., of the University of New Mexico, has underway one set of research studies on wayfinding technologies for mapping based upon work at the University of New Mexico campus. Also, Blasch (1981, 1982) has been investigating unique mapping contents including grade, cross slope and surface texture. These maps have been used in orienteering activities. (For a review of other techniques and some insight into their use, see Bentzen, 1980.)

The Use of Orientation Aids

Mobility specialists have generally applauded efforts to extend the technology and techniques available to individuals who need mobility devices and orientation aids. However, there has not been any evidence to suggest that the previously described technologies will replace the need for environmental adaptations for some or all users. Specialists have hypothesized a number of factors to explain why technological aids are not used by all those who might benefit from them.

Some consumers, particularly older ones, are reluctant to adopt gadgets. Some professionals — including orientation and mobility specialists — are reluctant to instruct potential users about devices which have not proven their value. Also, aids can be costly, unreliable, bulky or otherwise inconvenient. Some aids are sold with inadequate instructions. Others present users with too much stimulation or block other essential sensory-motor inputs. Then there are aids which provide information features which are not essential to wayfinding. Many mobility aids are not equally useful indoors and out (Hill & Ponder, 1976). Some users object to aids that draw undue attention to the user. Research regarding these possible explanations for reluctance to adopt available technological aids may serve to direct the development of appropriate technology as well as provide useful information on the orientational and guidance systems needed by a full range of individuals.

Technology for Hearing Impaired Persons

There are possibilities for implantation of the vision, auditory and other systems as future means for overcoming some orientational deficits (Grady, 1981). Dr. Frank Withrow, Chief of Educational Technology Development in 1980 for the U.S. Office of Education, stated that hearing aid implantation is already under development and may be one means of overcoming hearing losses of future, if not this generation (Contributions of..., 1980).

More immediately, there are available technologies which are on the market but not widely used which would appear to benefit hearing impaired individuals. As with aids for visually impaired persons, research on these in specific environmental applications is sparse.

Medium Level Technologies

Equipment for wiring rooms or making necessary annunciators more directive and discernable has been available for well over ten years. (For an excellent review of specific devices and their approximate cost, see Elderly Hearing Impaired Persons, 1981; Alternative Listening Devices, 1981.) Some of these systems would allow the walls to direct sounds selectively. Such technologies might be appropriate for aiding orientation in public transit areas, museums, or community buildings.

Portable Systems

Castle (1979) has assembled a pictorial brochure on portable devices for signaling and amplification. The simple mechanics of vibrating alarms and flashing clocks would seem useful in orienting people to time signals (where bells might be used to announce class changes in a school, for example).

Multi-purpose Signaling Systems (Applied Communications Corporation) are portable units which, when plugged in, can be attached to a telephone, doorbell or other sound emanating appliance. These are portable enough for a traveler to use to pick up doorbells. With minor accessories they can also pick up door knocks (Castle, 1979).

The Sonic Alert (manufactured by Sonic Alert, Inc.) plugs into an electrical outlet and uses separate battery-operated transmitters to detect up to five different sounds. The user applies a special tape near the object (such as phone, door bell, or timer) and adjusts the sensitivity of the transmitter for that sound. A lamp or vibrator can be used to transmit a different signal according to which device has been triggered.

Sound lamps could be used to help signal the hearing impaired traveler that a public announcement (flight change, gate change, or page) has occurred. By combining such systems with computer monitors, the hearing impaired individual would be able to at least check a source to determine appropriate information. Systems of this type do not seem to be in use in public areas; however, Pilgrim Towers, a retirement residence for hearing impaired persons in Los Angeles, has rigged up similar systems for residential communication.

One sound lamp, manufactured by Hal-Hen, is a small device which includes an 8" glass globe, microphone, and microphone sensitivity control. The microphone will sense sounds from voices to doorbells, and can be adjusted from loud to soft.

Portable Products for Communication

There are a few battery-operated devices available to help minor to moderately hearing impaired individuals make use of existing telephone and communication systems. The Deluxe Nuvox Portable Telephone Amplifier by Hal-Hen, and the Magstat Doorbell Phone Ringing Set, by American Communication Corporation are examples of such systems.

Portable and Semi-Portable Products for Information Gathering and Amplification

To aid the hearing impaired individual who might need selective amplification in a large transportation center, shopping plaza, or public residence, the teleloop technology may be appropriate. The teleloop is a lightweight antenna placed around the listener's neck and connected to a tape recorder, P.A. system, or other sound emitting device(radio, tv, etc.). (See Phonic Ear Teleloop by HC Electronics, and Amplitel Loop Induction by Hal-Hen.) The Amplitel Loop can also be used for group listening where several hearing impaired people might receive information at the same time (Castle, 1979).

Handling Emergencies

In emergency situations, it might be important to be able to summon deaf or severely hearing impaired persons and to direct those persons to an appropriate evacuation route or otherwise guide him or her. Individual vibrating pagers for contacting such persons are a possible means for selective, non-obtrusive paging of hearing impaired persons (Contributions..., 1980).

There are several techniques for handling fire and smoke detection signaling (Castle, 1979; Contributions..., 1980; Hale, 1979) ranging from flashing lights to vibrating pillow alarms. The point is that while a variety of options are available, residences for older and other high risk groups typically do not have alternative signaling devices for hearing impaired users.

Elevator signaling systems have been developed which might advise a trapped passenger that "help is on the way" (Contributions..., 1980).

Teletypewriters (TTY) and Telecommunications Devices

These devices are offering new possibilities for two-way communication for deaf persons (who are otherwise fairly able). TTY's permit typed messages to be transmitted through standard telephone services (Hale, 1979). They can be large and bulky or small and portable, each type has its advantages in terms of the manual dexterity of its users. Most often these have been placed in transportation terminals and educational environments specially designed for deaf persons. They have not, as yet, been widely integrated into the design of community or residential settings such as senior centers or retirement housing, nor have they been tested with a fuller range of multiply impaired users.

Other high technologies currently under investigation include videodiscs to allow deaf and hearing impaired persons to scan and retrieve information and the decoding of spoken words as necessary (Rehab Brief, 1980).

Comments on Technology Enhancements and Hearing Impaired Users

There are several areas where policy and research need to be combined to benefit the independent wayfinding skills of deaf and hearing impaired persons.

First, the hearing aid itself has fallen under much criticism for its limitations in amplification especially for older users who constitute the overwhelming majority of hearing impaired pedestrians (Maurer & Rupp, 1979; Corso, 1982; Winer, 1980).

Second, environments have still not been well conceived in terms of facilitating conversations of hearing impaired persons, transactions which may be necessary to giving and obtaining directions. Hard surfaces have been used to make buildings fire resistant. These same materials often combine to increase problems of ambient noise echos and voice transmission. More creative use of textures and provision of acoustically protected areas for orienting cues would be most beneficial. Model configurations for information booths (to protect the listener from unwanted background noise) and for reception areas would also be helpful.

Third, the public has underestimated the needs of hearing impaired persons, the inconvenience, the dependency and the loss in time which results from ignoring the environment and technology. Perhaps some model programs and design would help increase consumer knowledge and use of available products (Elderly Hearing Impaired People, 1981; Hiatt, 1982).

Fourth, the information on special products which are available seems to be poorly disseminated to those who might use them. For example, the items described by Castle (1979) are not well known to either individual consumers, housing managers, public facilities and plant operations people, or others who might purchase them. Some effort to disseminate information on these devices and appropriately to recommend their use is needed.

Computers as Aids to Wayfinding

A multitude of areas are being broached for computer application. Because of the newness of computer applications, some speculative suggestions for wayfinding and orientation are hypothesized based on existing factual information.

1. The computer can provide an educational tool for training or wayfiding and may be particularly useful in simulating mapping, directions, and routing.

2. The computer may enhance senses by acting as a translator. The computer may translate audio output or tactile displays for people who are deaf or blind (Vanderheiden, 1982).

3. As a manipulator/controller, the computer may offer remote actuators and draw upon robotics to allow one to manipulate otherwise unmovable or impassible objects (Vanderheiden, 1982, p. 139). Work on this theme is still in the conceptual stage and is hampered by the large number of signals required to control robots or manipulators.

4. To allow the user to control the speed of information, computers have been applied to information amplification (Vanderheiden, 1982). To ask instructions, for example, individuals with motor impairments affecting communication (such as cerebral palsy) might use the computer to augment their communication (Baker, 1982), to make them more readily understood by their peers. Vanderheiden (1982) proposes that the impaired individual might enter information in highly abbreviated forms; when spoken by the computer, it would be transformed into more conventional speech. This technology is in early stages of development, though some software has been devised.

5. Computers may be used to maximize residual capabilities and minimize disabilities by controlling other devices. While this technology has not been specifically applied to controlling signs, landmarks, street signals or other traffic devices, it would seem compatible with approaches described previously (see SONA).

6. As a learning aid, the computer may be more patient and systematic than some instructors, allowing practice in such skills as map reading and making, direction finding, planning routes, or interpreting signals. Microcomputers would allow individuals to practice some wayfinding approaches independently.

7. As a memory aid and for information management, computers may be used like notepads and notebooks. Thus, they may have an application in recording directions, making up personal routes, or even keeping address listings. This might be especially helpful for disoriented older persons as well as those prone to becoming lost.

8. As aids for communication impaired persons, computers have been put to only limited use at present (Vanderheiden, 1982) because of their bulkiness and stationary design. However, portable, hand-held computers (sometimes toys) are increasing. (Note the research being done by Demasco & Foulds, 1982, at Tufts-New England Medical Center.) Vanderheiden notes that present technology suggests that the fine motor skills required by portable systems will limit their utility to people with only minor to moderate communication needs but even that will help a majority of users. As computer technology in general is improved in terms of more widely accessible interfacing, aids for communication impaired individuals may be improved and made available.

There is already a voice-entry terminal (SHADOW/VET) for the Apple (TM), developed by Scott Instruments (Maggs & Visek, 1981; Vanderheiden, 1982, p. 154). This system can be used for nearly any program which requires keyboard use. Technology could be applied to such tasks as obtaining directory information in a large public building by both sight- or communication-impaired persons.

There is also a simple voice recognition output program ($295.00) which was developed as a "key" or security device for people unable to use keys or card systems. This program has been suggested also as a means of voice output for visually impaired persons (Murray, 1982). This system works with an Apple (TM) computer, and might be useful for specialized orienting systems necessary in workplaces or secure environments.

One of the issues raised by the development of computer technologies is whether special devices for specific uses (such as wayfinding, speaking, computations, memory) should be created or whether a combined unit should be planned.

9. As security and monitoring devices, the computer can provide information related to intruders. This same technology may be useful in wayfinding and orientation to allow people to identify or be oriented to the location of others in large, underpopulated settings (such as locating a person to whom questions regarding directions might be addressed).

The computer may also be integrated into some techniques for calling for assistance, such as when one is alone, lost or unable to find or get to a phone. As an example of this technology, see the Abilityphone manufactured by Basic Telecommunications Corporation, ($2335) (Rush, 1982), which will dial emergency information (a predetermined phone number). It will also monitor ("are you okay?"), remind, and repeat dial. The device might help severely disabled travelers (including those with cerebral palsy or other impairments affecting communication, use of fingers and hands, and even hearing) in major transportation centers.

10. Tactile or audio mapping may also be possible using computers (Blasch). There are already audio screens on which a computer registers sound rather than visual output and word processors that print in braille (Vanderheiden, 1982, p. 148-9). A flat tablet placed next to the computer can be activated with a pen-like light cursor. By running the light pen over the tablet, information on the tablet is spoken or read to the individual through the computer's audio system. Because the user controls the placement of the pen, it may be useful in map reading.

11. Everett Hill, Ph.D., at the George Peabody College has been using computers to assess the wayfinding deficits and knowledge of blind travelers. The resulting knowledge of the individual's confusion is helpful in targeting training and planning appropriate assistance. It would seem that the software they have devised might be useful for others.

12. Computers may also be useful to designers in planning overall orientational and signage schemes, predicting problem areas, and projecting the relative effects of various solutions. Such uses would combine modeling, graphic technologies and other available techniques for projection.

Limitations of Computer Technologies

Computer applications are expanding rapidly. One of the fascinating aspects of the emerging technology is the untapped potential. Another is the parallel evolution of scientific work which is benefitting a variety of able and disabled users.

However, extreme caution is warranted regarding such technologies as computerized orientational systems, robotics, or even high technology devices in the immediate future. The majority of individuals needing orientation may well be elderly. This population has not been as adequately exposed to direct use of technologies as have school-aged children. Other factors which must be considered in planning for the adoption of new computer technologies include cost, access and the need for training. Even typing skills may be a short-term barrier to use of these high technologies. If the systems are down, the individual must have alternatives and therefore the technology must be viewed as an adjunct or tool for the individual's basic resourcefulness in wayfinding. This is not to dampen the enthusiasm, but rather to urge the development of an overall research and development plan which would resolve some pressing present-day needs without negating the potential for computers to streamline the system in the future.

HAZARDOUS ELEMENTS SUCH AS STAIRS

The standards prepared by many states identify stairs or hazardous areas by knurling doorway handles. In a few cases, signage is specified. In general, hazardous areas seem to be left to the discretion of the building owner or sponsor to deal with. There are no data reported on the need for signage to identify hazards. This would seem to be an oversight. The first task is to identify probable hazards for different disability groups. A second is to use the appropriate signs for each.

Stairs are a particular problem. Most think of the difficulties in terms of totally blind users. In addition, stairs are dangerous to visually impaired and older users in terms of falls (Overstall & Isaacs, 1978; Toglia, 1975; Waller, 1978). For the visually impaired, the problems may range from detecting stair edges (Genensky, 1980) to identifying openings once one is in the stairwell. Stairs used for fire evacuation vary widely in terms of the lighting used. More effort needs to go into the identification of the edges of steps and on door signs and clarification of egress once one is inside a stairwell.

Shanas' study (1980) indicates that 24% of one large sample of persons 65 and over had difficulties climbing stairs. Older women were about 1.5 times as likely to have problems as older men. The older people are, the more difficult stairs were reported to be; 37% of the 65-69 age group reported difficulties in contrast to 58% of those aged 80 and over. One of the primary weaknesses of stair design besides the steps is the

TABLE 2
HAZARDOUS ELEMENTS

USER GROUP	EXAMPLES OF HAZARDS	CUEING, SIGNAGE OR METHOD OF DESIGNATION
Visually Impaired Persons	Overhanging objects.	1. Change in ground surfaces. color contrast and texture. 2. With new technology. the orientation aids *may* be helpful.
	Curb cuts which flow into traffic.	Change in ground texture.
	Doors leading to stairs.	Tactile signs *and* knurling of handles (signs might be directly on the door rather than to one side.)
Hearing Impaired Person	Fire or evacuation signal (especially if living or working alone).	Visual or vibrating call systems.
Older (Presuming Likely Visual Deficit)	Sloped area or ramp (for upright mobile individual).	(Note: Handrail may be very important).

NOTE: The first objective would be to reduce the risk associated with the hazard. This table represents proposed follow-up measures.

inadequacy of many handrail systems. Signage or orientational information do not alleviate these difficulties. However, route maps which identify where stairs are and offer alternative routes would be helpful to many handicapped and older users.

If signage were developed to signal stairs, then it would also be important to advocate the identification of ramps which are also a potential hazard. Even the ANSI Standards for 1980 fall short of identifying the problems of crutch users, and unstable or older persons with ramps (Rodstein, 1978; Waller, 1979).

Dizziness, vertigo, and weakness may result in various negative outcomes (Overstall & Isaacs, 1978; Toglia, 1975) and are of concern to people with heart disease as well as other impairments and disorders. It would seem that some sensitivity to the needs of users who cannot deal with exertion, stress or who are at risk of falls is advisable. Signage could also be used to indicate resting or seating places of particular concern in public buildings and larger facilities as well as along long routes.

Other risks and hazards are discussed in the context of circulation areas and egress, needs of deaf and hearing impaired persons, and people under stress in earlier sections of this report.

OVERVIEW OF THE IMPACT OF CURRENT BUILDING CODE REGULATIONS

Introduction

Material presented in this section is based upon a synopsis, prepared by Ms. Sally Free, staff member of the Architectural and Transportation Barriers Compliance Board. (See Appendix B.) Building codes analyzed are constantly subject to change; this information is therefore based upon an examination of material available as of 8/26/82. The authors wish to express their appreciation for the detailed work that went into aggregating the raw materials for this analysis.

The synopsis provided is based upon 40 states and the ANSI-1980 and 1961 specifications.

In addition, information was taken from selected sections of about 32 of these state codes, resource handbooks and self-teaching guides. These materials were used in the section on Examples of Codes and Related Material following.

What Areas Are Covered in Building Codes Pertinent to Wayfinding?

The items listed below have been categorized by the authors. The category labels, also developed by the authors of this report, may be helpful in suggesting points which should be addressed in future codes. Not all states whose material or codes were reviewed offered requirements on suggestions in each of these topics. As a result it is difficult for readers to get an overall picture of the goals of various requirements.

What Spaces or Decision Nodes Are Vulnerable to Disorientation and Therefore Need Some Indicators or Signs?

1. Entrances, exits
2. Circulation routes
3. Rooms and spaces: offices, public areas, toilets/restrooms
4. Elevators

What Objects or Features Should be Identified for the Users?

1. Telephones
2. Exits
3. Hazards

4. Directories
5. Elevator controls and signals
6. Wheelchair accessible entrances
7. Wheelchair accessible rooms
8. User specific information as for hearing or speech impaired persons

What Special Information on or About Signs is Required or Recommended?

1. All print/type should be legible usually operationalized in terms of a specific size; width and or height; and/or typeface.

2. Lighting and contrast should be considered in some aspect of lettering to background and/or background of sign to surface/wall.

3. The access symbol should be used and symbols should be designated for more than wheelchair access (such as, access to hearing impaired).

4. Signs should be tactile (raised and/or recessed lettering be used; that symbols and/or letters and numbers be tactile).

5. Braille should be used.

6. Height for protruding and/or flush signs should be specific and/or within a range as given.

7. Certain spaces should be labeled.

8. Knurled (textured) door knobs should be provided to indicate danger behind a door.

Nearly a third (13/40) of the states had requirements for fewer than three of all of the items listed above. And only about a fourth (11/40) had some mention of the majority of items noted. This may indicate that there is a lack of understanding of the issues of orientation and/or that a priority has not been placed on these topics. It would be worthwhile to consider the present progress prior to requiring a very rigid national system of orientation. And yet it would seem that orientational guidance is likely to be fairly easily presented because it should be beneficial not only to disabled Americans but to the general populace as well.

Do the Preceding Topics Express the Issues?

The three basic issues to which the codes seem to respond are relevant to orientation.

Many practical problems arise because users are viewed too simplistically as representing the extremes of disability (totally blind rather than possibly partially sighted). Then, too, problems arise from overlooking disability groups in the codes (such as persons with hearing impairments) and from failing to consider the needs of persons with multiple impairments (in a wheelchair and unable to see well). Issues such as neck movement (necessary to see or read signs) and range of arm motion (necessary to use tactile signs and controls) have not been clearly integrated into the requirements of signage. Highlights from the stronger and weaker points of the codes follow.

Inconsistencies in Spaces Singled Out for Labeling

There seems to be some irony in the spaces selected for labeling (Table 2). Why elevators and not toilets or telephones? Why spaces and not routes? Why so little emphasis on identification of emergency routes? Why are temporary hazards or temporarily used places excluded from signage (when it could be argued that these are the most in need of tactile labeling to minimize hazards)? In fact, why are hazards so seldom acknowledged? It is the authors' position that each of these is significant and warrants labeling.

There is fairly widespread information on wheelchair users related to these specific areas: toilets, bathrooms, and phone booths. Some 25% of the codes and related materials are particularly well illustrated with respect to the needs of wheelchair users, though others seem to leave a lot to the imagination. There seem to be a variety of ideas and general indication of innovative approaches possible for accessibility for these users, though no single set of practices has emerged across the U.S. (as reflected in state level regulations).

Height of Signals and Controls

Height of control signals at elevators is one area which seems to be unrelated to stance and visual field of the wheelchair user. The floor indicators in particular would seem to be too high relative to the visual range of persons with any but the best head movements.

Route Marking

There is also suprisingly little offered in either the codes or the accompanying materials on routes which are accessible in a complex building. This seems to be a significant oversight if the premise is accepted that orientation is a function of route as well as place name information.

Specifications included and omitted for totally blind users. Information pertaining to totally blind persons has increased, particularly in the more recently developed codes.

Specifications for Visually Impaired Users

The majority of visually impaired persons are partially sighted. The majority of partially sighted persons are elderly. Codes do not adequately respond to these users. For example:

Need For Contrast. Contrast which would aid visibility to the majority of low vision users is required by only half (21/40) of the state codes.

Need for Print Legibility. The majority of visually impaired persons (including blind, legally blind and low vision users) do not read braille. Braille signs are required in less than a fourth (9/40) of the states in question.

Need for Tactile (Beyond Braille) Signs and for Research on Tactile Signs. Low vision users (including elderly, legally blind persons and others) could be aided by tactile lettering. Tactile signs are required in some way or place by 80% of the states (32/40); however, as Table 3 shows, there are major differences in terms of where such signs are required.

Signs Need to be Within Visual and Tactile Range. Sign height will be important to visually impaired persons who may need to get close. Again, such persons tend to be elderly. Statistically speaking they are shorter than the public at large.

1. About 35% of the states studied had a height requirement for protruding signs and nearly 3/4 (had requirements for flush signs). For flush signs (where head clearance is not an issue), half were in a range of 4'6" to 5'6". Based on the limited anthropometric data available for elderly and for wheelchair users (who may also be visually impaired), the 5'0" height would seem to preclude touch for people with disorders affecting range of motion and for some would be out of the typical range of sight.

2. There have been some studies

reported in the literature which suggest that overhead, protruding signs are out of the normal field of vision and often at too far a distance to be visible to older persons (Windley & Scheidt, 1980; Waller, 1978; Wardell, 1980).

Lighting Must be Considered in Relation To Signs or Cues. The lack of information on lighting seems to be one of the primary limitations of recommendations for visually impaired and older users. States had little to say about placement of signs in relation to light. Also, the recent questions on use of fluorescents, their affect on attention span and nutrition of hyperactive children and elderly persons are not dealt with in the material reviewed. Again, this might be appropriate material for a handbook level of discussion. Only 10% of the states indirectly recognized the visual distortions in signage caused by glare. (These few typically recommended or required matte finish on signs.) This is another oversight because glare is repeatedly cited as a major issue in lack of attention and visual disability for visually impaired and some learning disabled persons.

Color. None of the states presented information or specifications with regard to color use itself, overlooking color deficits of older people vis-a-vis the yellowing of the human lens and the color deficient general population. While the information on contrast may be helpful, the trend in some states toward offering a handbook to accompany codes would seem to be a good place to present that information.

Specifications for Hearing Impaired Users

The information available to hearing impaired persons is sorely lacking. Specifically:

1. centrally located information systems or sign boards are overlooked (required in only one state);

2. availability of amplification is not specified;

3. emergency signaling for hearing impaired persons re: evacuation/fire is not required nor recommended.

With the amount of literature citing presbycusis as a major factor in hearing impairment and its tendency to reduce hearing in the higher frequencies, it is surprising that sound systems are not specified which will be lower pitched and more likely to be heard. At the handbook level, technology is improving and information on alternative methods of signalling announcements being made over public address systems and in major public buildings and transit center seems warranted.

There is little in the information requirements or advice on signage systems which reflects an understanding of the learning disabled or developmentally disabled population. At the outset some guidance regarding simplificaiton would seem appropriate.

Supplementary Material

There have been several references to the handbooks and accompanying manuals which interpret the codes in at least four helpful ways. The authors recommend that a major guide book be developed and used which captures the functional needs of users and then offers many ideas on translating these concepts into design, products, materials and specifications. Such a handbook might stimulate the development of state regulations as well as serve as an overall checklist of topics and users to be considered.

Some of these guidebooks explain how people function, what proportion they constitute in a population and how to translate functional issues into design. This type of information is helpful and of value.

A few illustrate alternatives, stimulating both an understanding of the principle and serving to translate otherwise complex terms and phrases. It is difficult to understand the topic of orientation without dealing in some sense with visual elements—even for visually impaired constituents.

Several of these guidebooks offer resource information for further guidance. See Arizona, Washington, Missouri, Illinois, West Virginia, Ohio, and North Carolina as examples.

It is important that additional handbooks/material, as well as information on specific types of environments, such as campuses (see Cotler & DeGraff, 1976, NY), libraries or work places be available.

Approaching the topic of orientation through signs and sign heights may be over-simplifying the solution based upon the common denominator of fragmented knowledge.

It would be helpful in the future to offer insights on overall building configurations, their relative imageability and utility and relate informational systems to the choices made with regard to configurations.

Similarly, topics such as color and signage type and location need to be considered as a function of lighting, glare, location, building configurations and familiarity of users with the space.

The information on print legibility needs to be broadened and specified to benefit the larger public. Currently, 3/4 of the states studied have no specification for the type size or style used in required signs. Six recommend sans serif signs. The new ANSI would accept Arabic. Recommendations on style have been made independently of type height, which seems to be a key in some of the conflicting data.

Alternative solutions, combining tested technology, human information systems and consumer-developed programs need to be accommodated or, better, stimulated.

The reader of a code should be given some insight as to how compliance is measured (texture, glare, "as needed" are difficult to translate). Similarly, the consumer/provider should be offered some method for reconciling new information, exceptions and research with specific detail. Perhaps such methods would make the development of specific requirements more pallitable and a more dynamic, participatory process.

Much of this information could well be shared with the sponsors of commercial buildings.

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"Color Vision Defects in the Elderly," M.E.K. Andreason, Journal of Gerontological Nursing, V. 6, N. 7, (1980), 3283-384.

Congenital color blindness, according to this review of contemporary literature, affects 9% of all males and 2% of all females. However, studies of older people have shown that perhaps 48% of those not formerly color impaired had color deficits. Conditions such as glaucoma, diabetic retinopathy and arteriosclerotic retinopathy (all of which may be more common among older people), render blue and yellow a grayish color. Some diabetics become impaired in color vision, making clinic test matching difficult.

"The Incidence and Type of Perceptual Deficiencies in the Aged," M.B. Bender, in Neurological and Sensory Disorders in the Elderly, W.S. Field, editor, Stratton Intercontinental Medical, New York, 1975, 23-31.

An empirical study of 238 older people , aged 60+, most (71%) of normal mental status who made office visits to a physician (1973) . Perceptual impairments were more common among the older people studied. Of 150 quite free of impairments in mental function, 48% showed defects in vibration sensitivity, probably due to arthritis and its interactive effects with other disorders.

Pseudoisochromatic scales were used to measure color vision of the 150 "mentally normal" individuals; about 3% were color blind, 48% had defects in color perception in contrast to 20% of people under age 60 (pp. 22-23).

Color deficiencies in older people may result from decreases in visual acuity, decreased background illumination, lesions in ocular media or retina (especially affects perception of lavendar) and diseases such as cataract, glaucoma, or retinal or macular degeneration.

"Orientation Aids," B.L. Bentzen., in Foundations of Orientation and Mobility, R.L. Welsh and B. Blasch, editors, American Foundation for the Blind, New York, 1980, 291-355.

The author presents a synopsis of aids to orientation, emphasizing models, tactile or visual graphics and simple aids. Many types of tactile/visual maps are illustrated. Some suggestions are offered on the relative merits of various techniques for teaching shape recognition, for using symbols, tracing, presenting information density, and for labeling through overlays. The author then describes visual graphic aids for low vision pedestrians and provides suggestions for graphic symbols (they should be larger), type size (18-point), and scale (small enough to minimize need for scanning). Color coding of maps is discussed, and the author suggests that with inconclusive data the best approach is to maximize contrast and minimize glare. The author summarizes the seminal works of Dr. John Gill at Warwick University, Coventry, England on computer designed and produced tactile graphic aids.

Comments: Some empirical data is cited to substantiate various recommendations made in the chapter, but the author contends that basic and applied research is inadequate in these areas, urging the participation of orientation and mobility specialists.

"Maps: An Orientation Aid for Visually Handicapped Persons," B.B. Blasch, R.L. Welsh, and T. Davidson, New Outlook for the Blind, V. 67, (1973), 145-158.

Auditory maps are a technique for introducing visually handicapped persons who are fully trained in the use of long-cane or guide dog mobility skills with a verbal description to orient them to a variety of places. Authors describe the use of auditory maps in orienting people to districts as well as along specific routes. The contents of such descriptive maps, recommended by the authors, include: (1) ego-centric: relating environments to one's own body with concepts of left, right, up, and down; (2) topo-centric: relating body position to environmental features such as landmarks (tactile, olfactory, audio cues); (3) cartographic: relating to the organized structures of man-made environments including streets, layouts, names and numbering; (4) polo-centric: using compass directions for efficiency and to develop overall spatial concepts.

To demonstrate their concept, sample scripts are included. In contrast to tactile mapping systems for visually impaired persons, auditory maps were judged easier to carry (less conspicuous), quicker to produce than tactile maps, and capable of greater detail. In addition, they do not require learning new skills such as braille or tactile manipulations. Some problems may occur in their use by older people unfamiliar with cassettes.

Most of the research on these maps is based upon college-aged students, and more needs to be done.

"A Growing Need: Resources for Information About Signaling Devices for the Hearing Impaired," D. Castle, Hearing Instruments, (July, 1979) 5 pp.

A description of devices for signaling, for transforming voice and other sounds into flashing lights or vibration, and for security. Illustrated with lists and addresses of manufacturers. (No evaluative or comparative data provided.)

Aging and Sensory Systems and Perception, J.F. Corso, New York: Praeger, 1981.

A comprehensive presentation of the author's research and existing literature presenting the state of the art on: visual systems, auditory systems, vestibular, gustatory, olfactory, somatosensory, as well as behavior implications in rehabilitation.

Comments: One of the few reviews or texts to deal (if briefly) with issues of orientation (p. 224) and color vision (57-58) and to suggest a variety of intervention strategies in view of the data outlined. The section on hearing loss, though technical, is notably well done.

Environmental Modifications for the Visually Impaired: A Handbook, J. Duncan, C. Gish, M.E. Mulholland, and A. Townsend, American Foundation for the Blind, New York, 1977.

A booklet of recommendations on building design features for totally blind and partially sighted individuals, including sources of information on such items as tactile plates for elevators.

Comments: Information presented is well-selected, covering topics of interest to designers and the public. However, documentation is not provided; some material seems to be repeated from other guides but not based upon empirical studies of the full range of visually impaired users.

Elderly Hearing Impaired People, A Report of the Mini-Conference of the White House Conference on Aging, January 11-13, 1981, U.S. Government Printing Office, Washington, D.C., 1981. Also available through Self-Help for Hard of Hearing, P.O. Box 34889, Washington, D.C. 20034.

Background information on the numbers of older hearing impaired people, on technologies ranging from amplification to the problems of hearing aids, training, communication access, and the environment. Also includes a synopsis of existing and underutilized technology. Recommendations are offered for improving problems outlined.

"Cognitive Mapping and Architecture," G.W. Evans, J. Fellows, M. Zorn and K. Doty. Journal of Applied Psychology, V. 65, (1980), 474-478.

A study on the merits of color coding one central core wall of a building differently from the exterior hallway. The orienting and way-finding abilities of two groups of seven college students were studied, one group was tested prior to painting the walls the contrasting colors. Persons in the color coded condition made fewer errors in a way finding task and had higher recall for floor plans. Authors suggest that color coding may have less impact upon regular building users than on newcomers. Since signs were also changed in the color coding condition, results must be tentatively interpreted and suggest that color in combination with signs may have contributed to the outcome.

Comments: The authors suggest that their results indicate the significance of color coding to improve legibility of environments for elderly people and mental patients without sufficient explanation. Several factors need clarification. The college students were all advised in an initial tour that the study focus was "building architecture". Such comments may have made subjects more alert to color as a means of organizing spatial information than other populations might be. The effects of orienting tours, of signs, of relative amounts of color and of color perception need to be addressed in subsequent research.

"Cognitive Mapping: Knowledge of Real-World Distance and Location Information," G.W. Evans and K. Pezdek, Journal of Experimental Psychology, Human Learning and Memory, V. 6 (1980), 13-24.

Laboratory experiments indicated that students' recall of places may be improved through experiences in map reading, but that actual experience improves knowledge of the building in many views and positions. Such knowledge is more flexible.

"The Effects of an Explicit Landmark on Spatial Judgments," L.A. Fehr and H.D. Fishbein, in The Behavioral Basis of Design, Book 1: Selected Papers, P. Suedfeld and J.A. Russell, editors, Dowden, Hutchinson & Ross, Inc., Stroudsburg, PA (edra 7), 1976, 86-94.

An experiment was conducted and is described involving 240 primary school children and 80 college students and their use of landmarks. A laboratory study indicated that landmarks were particularly helpful for the youngest age groups and played a more significant role for all people studied as tasks became more complex and difficult.

"Transit Map Color Coding and Street Detail: Effects on Trip Planning Performance," H.C. Garland, J.J. Haynes and G.C. Grubb, Environment and Behavior, V. 11, N. 2, (June, 1979), pp. 162-184.

What information does the transit system user require? While maps are the most widely used information sources, the authors cite literature indicating that human sources (telephone, driver, or other passengers) are preferred to written information. The authors discuss two sources of difficulty in transit map comprehension: the users and the map itself. Color coded maps were found superior to three others tested by 77 college students. That is, when street detail was high, color coding of the transit routes resulted in greater trip planning accuracy, less perceived difficulty, less frustration and higher confidence. However, a map which provided only skeletal detail and used no color was fairly useful. Authors suggest that the average rate of six errors per student in map reading tasks are an indication of the need for map reading training, especially in urban areas.

"Urbanism from the Perspective of Ecological Psychologists," P.V. Gump and B. Adelberg, Environment and Behavior, V. 10, N. 2, (June, 1978), pp. 171-191.

This review article on urbanism summarizes literature on how a way of life derives from the characteristics of the environment. The experiences of elementary school children in small, medium and large communities are contrasted. Highlights from empirical studies are cited:

1. Small-town children knew more places, people and activities in the communities than did the city children. Though neither group was homebound, the authors note that small-town children visit settings nearly twice as often as do city children and this redundancy may account for increased awareness.

2. Unescorted children were found more frequently in the trafficways of the small town. Evidently, being escorted by a parent reduced contact with objects.

3. Urban children tended to visit more settings designed specifically for children and fewer adult or community settings. In contrast the small-town children seemed relatively more experienced with adult, noncommercial settings. The authors offer suggestions for methods to study the impact of community size/complexity on behavior.

Children's Experience of Place, R. Hart, Irvington/Halsted, New York, 1979.

An account of the author's research and experiences with a group of children in Vermont regarding their spatial activities (play and experience), map making and use, and place knowledge. The account is rich with description, illustration and suggestions for contributing to spatial awareness of children in rural/suburban areas.

"Color and Care: The Selection and Use of Colors in Environments for Older People," L. Hiatt, Nursing Homes, V. 30, N. 3, (1981), 1 -22.

A review article summarizing factors which influence how older people perceive color, the meaning of color (to older people, it signifies change), and where colors can be used most effectively. Due to yellowing of the human lens and other visual changes affecting the need for light as well as memory alterations suggesting that abstract elements are more easily forgotten, it is recommended that color not be used alone as an orienting system but be combined with the use of readily identifiable, namable objects (examples cited). In a discussion of color combinations, the principle of contrast between foreground and background focal points is urged, as well as greater awareness of the relationship between lighting, texture and color perception. Color naming may be more difficult for older people, affecting some color coding orientational systems. Less effective use of colors are outlined along with ways organizations might go about making color selections. Author suggests using objects or landmarks in conjunction with color to aid in orientation of older people.

"Disorientation is More than a State of Mind," L. Hiatt, Nursing Homes, V. 29, N. 4, (1980), pp. 30-36.

Review of the literature on mental processes involved in orientation is applied to recommendations on environmental legibility and programs of intervention. Author's own site visits to geriatric facilities are used as ethnographic data questioning the value of supergraphics, symbols, blinking or neon lights, and floor or wall stripes as orienting markers. Floor plans were more useful to visitors and staff than to older occupants of environments studied; braille alone was not found to be a sufficient cue for the majority of blind elderly people; recessed letters were preferred to raised. Special cautions were raised about the effects of windows and glare in diminishing the efficacy of orienting systems offered.

Orientation and Mobility Techniques: A Guide for the Practitioner, E. Hill and P. Ponder, American Foundation for the Blind, New York, 1976.

A guidebook for practitioners with many implications for environmental features useful in orienting blind and visually impaired travelers, such as shorelining, street crossing, and elevators. Appendices, some authored by others, describe travel techniques for dealing with crowds, subways and adverse weather conditions.

"An Informal Model for the Prediction of Preference," S. Kaplan in Landscape Assessment: Values, Perception and Resources, E.H. Zube, R. Brush, and J. Fabos, editors, Dowden, Hutchison, Ross, Stroudsburg, PA, 1975.

Authors report that setting features which contribute to the ability to map a place also increase preference for that place. Keys to preference included: (1) coherence (continuous texture gradients, thematic color or grahics patterns, variable identifiable physical forms); and (2) moderate uncertainty (variety, moderate complexity, comparative spaciousness, and occasional irregularities).

"Sense of Direction, Spatial Orientation and Cognitive Maps," L. Kozlowski and K.J. Bryant, Journal of Experimental Psychology, Human Perception and Performance, V. 33, N. 4, (1977), 590-598.

Self-reports of the "sense of direction" abilities vs. actual orienting skills of adults were studied. Self-reports accurately reflected practice: people who could point out unseen goals in a familiar environment did judge themselves as better oriented. Authors conclude that improved orientation of people with a good sense of direction is not automatic and requires conscious effort as well as repeated practice and exposure to the environment. People with a good sense of direction were better than their counterparts in terms of giving and following directions (written or oral), remembering routes while auto passengers, and remembering written directions to a place. The better oriented liked to read maps, enjoyed giving directions, tried to remember landscape details when traveling, and when driving liked to find new routes and places. Most of the better oriented people had a positive role model for their orientational skills. Poorly oriented people reported feeling anxious when lost, more so than well oriented ones.

Planning and Managing Housing for the Elderly, M.P. Lawton, John Wiley, New York, 1975, pp. 161-164; 249.

Based upon available research and professional experience, the author recommends the following methods of improving orienting skills of older people in the design of housing: (1) reduction of total symmetry; (2) improved lighting; (3) special care to site entrance walks, exterior building entrances and ground-floor entryways; (4) minimizing ambiguity about where one should enter; (5) use of a specific, definite street address (not just a project name); (6) use of the nearest cross-street name on printed material to supplement the street address; (7) street number and name signs, visible from the sidewalk at the main entrance (via signs, paving, and/or other means).

He also urges managers to make certain that city street signs are provided at nearby intersections on each and every street.

For orienting once inside a building, Lawton recommends (1) a name directory (clearly legible); (2) directional signs indicating office, elevator or other important spaces; (3) planning elevators in a location visible from the entryway; and (4) displaying a large simple map of the neighborhood with transportation route numbers to distant locations.

Mimeographed sheets and bulletin boards, notes the author, can be used to supplement other orientation information and should be distributed to new tenants.

The Image of the City, K. Lynch, M.I.T. Press, Cambridge, MA, 1961.

Lynch proposes that the physical layout of a city can be thought of in terms of paths, edges, nodes entered into (intersections), landmarks seen from a distance, and districts.

Comment: This book is viewed as a classic in terms of stimulating research on urban form, environmental perception and on the utility of each of the six items of "imageability."

Breaking Through the Deafness Barrier — Environmental Accommodations for Hearing Impaired People, M. Milner, Washington, D.C., Gallaudet College, 1979.

This publication describes the invisible barrier experienced by hearing impaired individuals. The key elements, sound and sight, are discussed with regard to the accommodating environment. Specific design guidelines and signal systems are suggested.

Comment: This concise publication is recommended by the authors.

"Knowing About Environmental Knowing: The Current State of Theory and Research on Environmental Condition," G.T. Moore, Environment and Behavior, V. 11, N. 1, (March, 1979), 33-70.

This paper combines a literature review of theories and research on environmental cognition with suggestions for improving research and theory on symbolism and on differences in physical environmental variables. The author asserts that buildings are remembered primarily on the basis of their use significance and not because of architectural characteristics, and that objects are more readily remembered if they can be labeled.

Moore also cites literature from his own and others' work on children's knowledge of place in an effort to resolve some of the discrepancies in the research. Other topics reviewed include: differences due to cognitive difficulties; sex-related differences; length of residence and familiarity; travel effects; and ethnicity, culture, lifestyle and environmental meaning. Author notes that he has reviewed 332 studies on environmental cognition, conducted over the past 15 years, and that "only a handful explicitly look at physical or social environmental conditions in any attempt to ascertain the role of the sociophysical environmental variables" (p. 63).

Environmental Knowing, G.T. Moore & R.G. Golledge, editors, Dowden, Hutchinson & Ross/McGraw Hill, New York, 1976.

A collection of articles with a variety of approaches to wayfinding, orientation and theoretical issues on planning and designing environments.

"Are Some Maps Better than Others?" L. Noyes, Geography, V. 64, (1979), 303-306.

A summary of the literature on map reading. Print legibility studies are viewed as non-conclusive, though suggesting that extremes are less legible and that bold print is less effective, probably because of distortions in internal letter structure. Cap and small case are easier to read, perhaps because of the increase in white space and distinctive word shape resulting. Words should be arranged along straight lines, not curved, angled or split. Positioning of the first letter is key to legibility; it must be clear and in an uncluttered location. Color research suggests that colors are most effective when kept few in number (under 8) and when use is for categorization; patterns are difficult to read. Pale colors are apparently harder to read, but the author concedes that they may be used satisfactorily when the more important material contrasts significantly. No advantages are reported for three-dimensional views which seem to reduce efficiency and hide vital information.

"Visual and Verbal Memory for Objects and their Spatial Locations," K. Pezdek and G.W. Evans, Journal of Experimental Psychology, Human Learning and Memory, V. 5, (1979), 360-373.

A laboratory study indicated that naming buildings is a strategy that helps people recognize them more effectively. Author suggests that people may know where a building is without knowing what it looks like, that memory for names may function somewhat independently of memory for images.

"Perceiving the Visual Message," D. Pollet & P.C. Haskell, editors, in Sign systems for libraries—solving the wayfinding problem, R. R. Bowler Co., New York, 1979.

With a brief treatment of the visual organ and visual acuity various aspects of visual communication are discussed. While visual communication is dependent on the eye and brain, the emphasis in this chapter deals with how visual information can best be transferred within the limits of good design and sound economics for all users including those with less than optimal vision. There is a good treatment of many considerations (for example, legibility and readability, color, lighting, glare) however, there is not much supporting research.

"Modifications of Spatial Performance in Two Cohorts of Older Women," M. Quayhagen, University of Southern California, 1979, Dissertation Abstracts International, 1979, V. 39, N. 02, 0957B.

Two groups of older people, average age 56 and 69 were studied to determine whether a training technique directed at increasing spatial cues by encouraging individually generated methods for dealing with figure rotation was possible. Training demonstrated that people could improve these orientational skills but were no faster than prior to training. Visual abilities alone were not adequate to account for the results. Middle aged persons benefited more from training than did the older group.

"Human Aspects of Urban Form," A. Rapoport, in Toward a Man-Environment Approach to Urban Form and Design, A. Rapoport, editor, Pergamon, London, 1977.

A literature review on issues of city design in terms of perceptual geography. Author concludes that complex, ambiguous environments challenge individuals to involve themselves and increase their level of environmental awareness. Rich, complex and vivid environments are preferred, according to literature cited, to uniform, monotonous or chaotic ones.

"Matching Older Persons' Cognition with Their Use of Neighborhood Areas," V. Regnier, in Cognition and Perception, Man-Environment Interactions, B. Honikman, section editor, D.H. Carson, general editor, Environmental Design Research Association, Washington, D.C., 1974, (edra 5), 19-40.

An empirical study of 94 San Francisco older residents of two elderly apartment residences in terms of their use of retail and service facilities and the effects of urban density on their patterns of use indicated that busy streets were not a barrier to respondents. However, while busy streets do not keep a person from using a resource, they may affect traffic patterns (that is, movement might be via a less trafficked intersection). The results of other portions of the study suggest that cognitive maps might be used to determine areas frequented by older people. With such knowledge, the author suggests that efforts could be made to secure or otherwise enhance these areas for older users.

"Stressful Experiences in Urban Places: Some Implications for Design," C. Roberts, in Priorities for Environmental Design Research, S. Weidemann & J.R. Anderson, editors, Environmental Design Research Association, Washington, D.C., 1978, 182-194.

Eighty city residents, between the ages of 24-42, were interviewed in an empirical investigation of perceived urban stress. The study contrasted newcomers (6 mos. to 3 years) with natives who had lived in Manhattan 7+ years. The largest number of complaints about stress related to the social environment: travel (92% of respondents), services (80%), and interaction with strangers (75%) were common complaints. Noise affected 61%, ugliness 51%, and problems with one's apartment bothered 34%. Few differences were found between natives and newcomers. Charts are presented indicating how people reacted to the stresses they described. Among travel concerns, pedestrians were troubled about crossing streets safely given aggressive drivers. Drivers were troubled by street blockage.

"Environmental Psychology," J.A. Russell & L.M. Ward, Annual Review of Psychology, V. 33, (1982), 6512-688.

Environmental psychology is "that branch of psychology concerned with providing a systematic account of the relationship between person and environment" (p. 652). Authors review literature on planning and the image of place, travel, and behavior in places. They note that little is still known about children's developmental knowledge of space. Literature on stress, noise, density and crowding is also summarized.

"Students' Views of the World," T.F. Saarinen, in Image and the Environment: Cognitive Mapping and Spatial Behavior, R.M. Downs and D. Stea, editors, Aldine, Chicago, 1973.

Author's research indicates that images of physical and political geography of the world are based upon (1) endpoints, (2) easily remembered shape; (3) location; (4) size or population; (5) distinctive islands, (6) ocean frontage, and (7) clear and separate outlines.

"Perception of Traversed Distance: Intersections," E.K. Sadella and L.G. Staplin, Environment and Behavior, V. 12, N. 1, (March, 1980), pp. 65-79.

Three experiments were conducted and indicate that the perception of route length is influenced by the perceived number of right-angle turns which are required along the route. When more right turns were required, the routes were consistently perceived as longer. Results were not due to actual or perceived travel time, to any particular path design or the straight line distance between origin and destination.

"Self-Assessment of Physical Function: White and Black Elderly in the U.S.," E. Shanas, in Epidemiology of the Aging (Second National Conference March 28-29, 1977), S.J. Haynes and M. Feinleib, editors, U.S. Government Printing Office, Washington, D.C., NIH Publication 80-969, 1980, 269-285.

This study reports on the results of extensive interviews with community residents and an attempt to contrast black and white populations, men and women, in terms of self-assessments as to whether they are bedfast, housebound, or ambulatory. Results are presented in several tables. For the total population interviewed, 2% were bedfast, 5% housebound, and 93% ambulatory. Of those rated ambulatory, 7% went outdoors with difficulty. In general, black respondents reported slightly greater restrictions in mobility than did white respondents; the author suggests that this issue needs follow-up.

Twenty-four percent of the elderly had problems walking stairs; 44% of the blacks compared with 22% of the whites reported these difficulties and 28% of the women contrasted with 18% of the men found stairs to be a problem. Stairs were more of a concern the older the people sampled; 37% of the 65-69 age group reported difficulties in contrast to 58% of those 80 and over.

"The Development of Spatial Representations of Large Scale Environments," A.W. Siegel and S.H. White, in Advance in Child Development and Behavior (v. 10), H.W. Reese, editor, Academic Press, New York, 1975, 9-55.

A readable review of the literature on spatial behavior and development of children. The authors propose a model of spatial representations of young children ("Main Sequence Model") which includes notice of landmarks, route learning, cluster formation, and separation of self from the environment. Disturbances in spatial knowledge are reviewed, including those which result from damage to the parieto-occipital region of the right cerebral hemisphere. The authors contrast children's and adults' construction of spatial representations. In adults, locomotion is seen as especially critical.

"Technics: Office Acoustics. Pssst...shhh," Progressive Architecture, V. 9, (1979), 198-205.

Explanation of the concepts of controlling sound and arranging spaces to maximize attention span.

"Design Guidelines" to Make Crossing Structures Accessible to the Physically Handicapped, in J.A. Templer, J.D. Wineman, & C.M. Zimring, editors, Final Report for Federal Highway Administration, Washington, D.C., 1982.

Several studies are described in this report. First, a multiple-test experiment to discover appropriate gradients, lengths and rest area configurations. The second phase of the project tested two aspects of surface materials: slip-resistance and materials that would be detectable by visually impaired long cane users. Included in this final set of tests was a test of the impact of visual contrast of surfaces for partially-sighted individuals. The third phase of their project dealt with the orientation and wayfinding problems of crossing structures for visually impaired travelers. Counter measures were generated and tested. Recommendations are made for ramp gradients for various heights to be climbed. An equation for predicting surface detectability is provided, and recommendations are also made for detectable materials for visually impaired long cane travelers.

Comment: In spite of the limited sample size for some of the research conducted the authors regard these studies as offering good esults for basing recommendations. It is recommended to replicate these studies with larger samples.

"Creation of Environment: Mexico," E. Terrazas, in Arts of the Environment, G. Kepes, editor, Braziller, New York, 1972, 198-207.

A discussion of the communication and signs available in Mexico City, some of which were developed for the Olympic games. The illustrations and discussion of signs, graphics and banners/sculpture offers some interesting examples of how design and information can be combined.

"Distance Estimation from Cognitive Maps," P.W. Thorndyke, Cognitive Psychology, V. 13, (1981), pp. 526-550.

Four experiments were conducted to determine the effects of map design on estimates of distance. Results suggested that people perceptually scan a route or image a route from start to destination and then use each scan distance to determine a path distance. Map clutter is suggested as a great problem which introduces systematic errors in the estimate of distance. Author suggests future map development consider request-driven displays where the individual specifies the level of detail required and that care be taken in computer generated maps to offer information selectively.

"Individual Differences in Procedures for Knowledge Acquisition from Maps," P. Thorndyke and C. Stasz, Cognitive Psychology, V. 12 (1980), 137-175.

Learning can be improved by strategies that emphasize particular ways of encoding spatial information, of evaluating progress, and of focusing attention on unlearned information. The ability to learn from a map may depend upon the effectiveness of one's visual memory but is not substantially affected by increasing experience with maps. Findings based upon laboratory experiments.

"Distortions in Memory for Maps," B. Tversky. Cognitive Psychology, V. 13, (1981), 407-433.

A series of studies are reported on techniques adopted for remembering maps, environments and forms. The results are interpreted to suggest that people use a principle called perceptual alignment to make places and forms more regular than they really are. Such procedures make landmarks more prominent. However, distortions which may ease recall also probably distort distance for memory, notes the author.

"Computers Can Play a Dual Role for Disabled People," G. Vanderheiden, Byte, V. 7, N. 9, (1982), 136-162.

Extensive review of research and technology on computer applications to a wide variety of aspects of life.
Comment: One of the most thorough presentations of the topic we have seen.

"Some Factors Affecting Legibility of Printed Materials for Older Adults," J.M. Vanderplas and J.H. Vanderplas. Perceptual and Motor Skills, V. 50, (1980), 923-932.

A study is reported on the specific, relative legibility of printed matter in various type fonts, spacing and with different papers. Spacing and type font did aid legibility.

"The Human Lens — A Model System for Studying Aging," W.J. Vaughan, P. Schmitz, and I. Fatt, in Sensory Systems and Communication in the Elderly (Aging, Vol. 19), J.M. Ordy and K. Brizzee, editors, Raven Press, New York, 1979, 51-60.

A summary of the literature and new research on the physiology and functioning of the human lens and its role in vision. The yellowing of the older person's lens, which happens as a function of age, reduces the amount of light that reaches the retina and changes the spectral perception of colors. Older people are less sensitive to shorter, blue-green wavelengths of the spectrum.

"Falls Among the Elderly — Human Environmental Factors," J. Waller, Accident Analysis and Prevention, V. 10, (1978), 21-33.

A detailed analysis of why older people fall and how improved conditions of lighting, demarcation of edges and contrast might minimize such incidents.

"Environmental Modifications," K.T. Wardell, in Foundations of Orientation and Mobility, R.L. Welsh and B. Blasch, editors, American Foundation for the Blind, New York, 1980, 477-525.

Beginning with a brief description of the ANSI (1961) standards and the 1968 Architectural Barriers Act, the author reviews environmental modifications which have been suggested for visually impaired persons but are not necessarily adopted. Obstacles (impediments which can be detected) and hazards (obstructions in the path of travel which cannot be detected or negotiated using a standard long cane technique) are reviewed. Suggestions are presented and photographically illustrated for dealing with both obstacles and hazards including telephone booths, guy wires, wall fixtures, stairs and escalators, planters and shrubbery, placement of street signs, cantilevered display windows, stairs, and irregular intersections. Pros and cons of tactile guidestrips are suggested (from author's experience). The author also details suggestions for partially sighted persons: problems with step-down, use of color contrast (should be expanded, especially for stair edges), background color of signs in contrast to walls (recommended), and elevator numerals. The section on elevator signal systems is provided through the recommendations of blind students and includes suggestions for raised Arabic numerals in conjunction with braille, positioning of switches (55" max, 35" above cab floor, minimum), door casings, and type styles. The need for information directories usable by blind and visually impaired persons is stressed as are auditory traffic signals. Problems encountered by "right-on-red" signals are described and sketched. Five pages of bibliographic citations are offered.

Comment: This piece is a good resource for designers; however, many of the suggestions have not been studied for groups such as older visually impaired persons or for their implications for users of other disability types. After reading the suggestions for elevator signage outlining specifications for raised lettering, one cannot but wonder if the technology for creating raised figures for braille has not simply been generalized by its proponents as likely to be appropriate for low vision readers. The alternative, recessed letters, is not discussed.

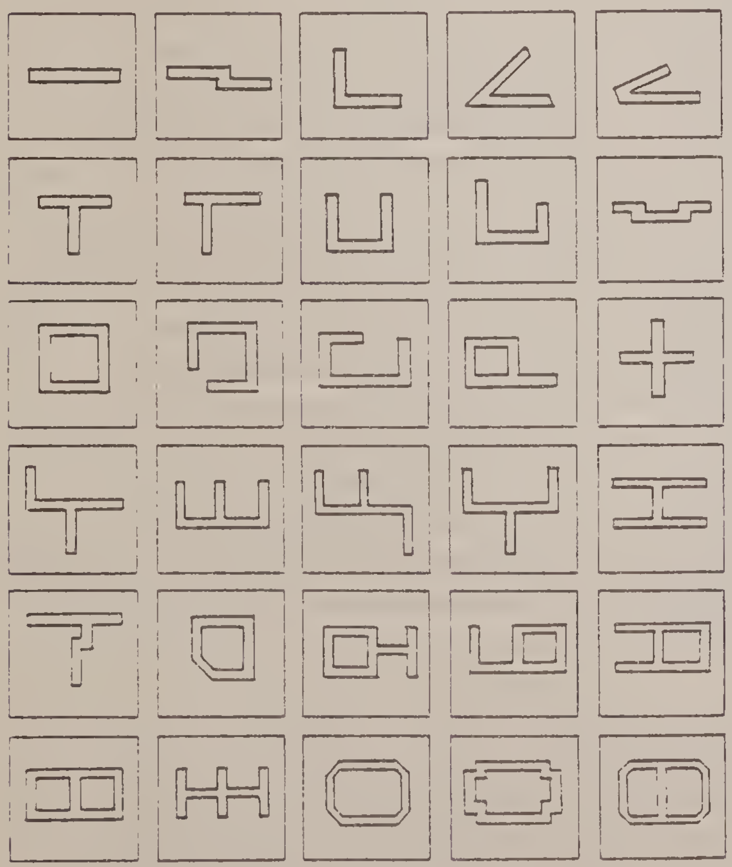
"Evaluating Architectural Legibility: Way-finding in the Built Environment," J. Weisman, Environment and Behavior, V. 13, N. 2, (March, 1981), 189-204.

A study of ten university buildings was conducted to determine the legibility of their plan configuration. The evaluation was based upon self-report data obtained from 73 college students, nine percent who were at least minimally familiar with the buildings reported becoming lost "often or almost always" and 14% reported at least one instance of being "quite" or "totally" lost. A combined 8% of the students had been both frequently and severely lost.

Does lack of familiarity alone explain disorientation? Data showed no clear-cut relationships between familiarity and the tendency to become disoriented in a building, suggesting that visual/spatial features of the environment probably combine with experience to explain the results.

Thirty examples of "good form" were developed in highly simplified, abstracted diagrams. (Examples were based upon gestalt psychology and represent the configurations of many contemporary buildings including those studied.) Independent raters examined the abstracted forms and indicated their (1) preference, (2) judgment of complexity, (3) ease with which the diagram could be described to another, (4) ease of memorization, and (5) judged ease of way-finding. Results obtained in the actual study could then be compared with raters' judgment of the abstract forms to determine whether configuration itself predicts disorientation. Simplicity of floorplan accounted for 56% of the variance in difficulty whereas familiarity with the building accounted for only 9% of the disorientation.

FIGURE 1:
A CATALOG OF SPATIAL CONFIGUATION



SOURCE: Weissman (1979)

The author reports that only about eight other empirical investigations on way-finding have been conducted.

The author recommends that the diagrams might be useful as a pre-construction simulation to determine potential legibility of a given environment.

Comments: The survey instrument, which is included, may have good applicability for studying legibility of other buildings.

The author also includes a graphic of the 30 diagrams utilized to determine good form, but does not annotate each on the terms of its ease or difficulty of legibility.

"Wayfinding in the Built Environment: A Study in Architectural Legibility," J. Weisman, Doctoral Dissertation, University of Michigan, 1979, Dissertation Abstracts, V. 40, N. 5051 (1979), 790-16, 843.

Self-reports of 73 University of Michigan students for wayfinding in each of ten buildings were used to analyze the efficacy of various sources of environmental information. Building designs with greater visual differentiation among various subsections and with more regular floor plans (such as parallel stairs and stacking of like hallways) were more easily remembered. Ten percent of the users reported some or frequent disorientation; familiarity for a building did not account for all of the variance in wayfinding; however, simplicity of shape accounted for 56% of the ease of orientation and use. Author notes that buildings were limited in signage which may have made plan configurations more relevant.

"Audition," W.R. Wiener, in Foundations of Orientation and Mobility, R.L. Welsh and B. Blasch, editors, American Foundation for the Blind, New York, 1980, 115-185.

A review of literature on auditory perception (well illustrated) and classification of hearing losses, including pathologies of the ear. Otosclerosis, the most common cause of hearing loss in adults, is described (an inherited disease of the middle ear affecting 10% of the population, 55% of whom sustain a hearing loss as a result). The disease may cause tinnitus, ringing in the ears, or vertigo. Individuals with this disease are an exception to the hearing patterns of most aged people; they hear better in noisy environments, a situation termed "paracusia willisiana." Data are presented on signal detection, on interpretation of traffic sounds, and the use of reflected sounds. Studies on orientation of visually impaired persons with accompanying hearing impairments are cited and reviewed; there is some indication from these that people learn orientation more slowly outdoors than indoors, and that weather conditions such as wind, shade and olfactory stimulation interfere with training. Obstacle and echo perception are discussed with implications for general design. The author's list of functional training tasks (presented to aid educators) may be of assistance to designers in outlining some of the practical difficulties experienced by some hearing impaired people. Auditory maps are recommended, using actual sounds of an environment to prepare persons for travel in a new area (especially visually impaired persons); however, such maps are seen as no substitute for actual experience.

Finally, the author presents and critiques various forms of hearing aids and describes the distortions some systems of amplification cause.

Comments: The material provides a complete review of research with thorough documentation. Because the use of auditory information is so important for visually impaired individuals, this chapter is highly recommended by the authors and in particular the section on auditory training.

INTRODUCTION

One of the most difficult issues on the topic of orientation and wayfinding is the dilemma posed by the piecemeal nature of the information available and the pressing concern that more could be done.

Simply stated, the orientation and wayfinding problems include (1) reducing risks at intersections or building nodes, (2) improving information to aid independent wayfinding, (3) training people in wayfinding for special users, and (4) using the available technologies and materials in creating better landmarks, signs and directions.

Throughout Section One, there has been an attempt to weave together the sparse and specific findings on how people function, how orientation seems to operate, how specific disabilities are affected, and what innovations in training and material promise. And, while there is some question about the research basis for much that is published, it is possible to translate what is known (or not known) into some immediate activities.

Further, it is imperative that the future steps be the right steps and that the immediate steps lead in a meaningful way toward problem solving.

There are lessons to be learned from the experience of the accessibility movement, where dollars have been spent to change bathrooms, and wheelchair users complain that they are still unable to independently use facilities because the design was not completely implemented. For example, the door of the bathroom stall must remain open to accommodate the wheelchair. While one might argue that the improvements made in public restrooms offer a situation far superior to the previous designs (and for many, they do), what would it have taken to think through the problem just a bit more, to consider entryways or location of controls or the height of the water closet? Were elongated sinks needed, or if they were, did the increased length suggest some reorganization of faucets, soap and mirror?

Orientation and wayfinding problems may be more subtle than accessible bathrooms. That is, where there was a vocal public asking for accessible toilets for wheelchair users, there have not been as yet such loud voices requesting legible environments. This is not to diminish the need, but rather to point out that (1) there may be time to "do things right," and (2) public information must be a central part of whatever "things" are done to the setting.

Using the example above, one of the greatest side-benefits of accessible toilets was the awareness of the public of the basic needs of handicapped individuals. Another benefit was the potential that architectural features had in contributing to personal independence and participation as a full member of the community.

Improved orientation and wayfinding systems should have other beneficial effects for individuals and for the public in general. The work done on curb cuts exemplifies the importance of surveying a broad constituency of consumers and of evaluating various systems prior to widescale, expensive adoption of a solution that benefits onlya partial segment of the population and poses a hazard to others.

Although it might be argued that improving bathrooms did little for the public as a whole, many non-wheelchair users have surreptitiously taken advantage of a more spacious cubicle when they needed to assist a child, carried luggage, or wished to change clothes. Similarly, improving legibility may offer the public at large some valuable benefits: reduced stress (which might influence activities such as consumer behavior), greater self-directed activity (thus relieving crowding or congestion and related risks at entries) and fuller attention to potential hazards or other elements rather than directions alone. Problems once attributed to some of the effects of disabling conditions (for example, problems with orientation and wayfinding) are now found to be the result of environmental design. Therefore, many facets of the built environment have made disoriented travelers out of disabled and able-bodied travelers alike.

In this section of the paper, major research questions related to orientation and wayfinding will be delineated and methods to undertake these studies suggested.

WAYFINDING RESEARCH

Research Need. The development of a national interdisciplinary consensus of a blueprint for the systematic research on orientation and wayfinding.

Sporadic and uncoordinated investigations have been done (see Section One) by architects, perceptual and environmental psychologists, mobility specialists and others relevant to wayfinding. However, these pieces have never been designed to fit into a larger plan. In this case the whole is greater than the sum of its parts. Stated another way, all of the ingredients must be assembled according to some formula or the product can be a waste or disaster.

It is therefore critical to bring together the most knowledgeable people from the various related disciplines for a more effective outcome.

The achievement of such an ambitious goal requires careful planning. Much of the effort in the past has been piecemeal, uncoordinated and myopic. As a result of the current economic situation, uncoordinated efforts are totally inappropriate and unaffordable. Effective planning has become vital to industry, cities, states and the federal government, and it must become a central theme in the area of human services and accessibility.

Proposed Research. The following plan is proposed as a means of accomplishing this goal. A workshop coordinator should select a small group (5-7) of distinguished professionals representing a variety of disciplines (for example, architecture, mobility training, environmental and perceptual psychology).

The Planning Committee should meet approximately 7-10 months before the workshop. The task of this Planning Committee would include the following: select a list of 4-6 content areas or subtopics to be addressed; select a list of 30-35 knowledgeable participants; develop a list of participants as alternates; assign participants to one of the content areas; designate one or two members of each content area to prepare a position paper (or use sections of the Hiatt and Blasch paper); and decide on a date for the workshop. The workshop coordinator would then invite the participants to the workshop and explain their obligations. From this point the workshop procedure would be as follows:

1. One (or two) member(s) of each subtopic group would be selected to prepare a position paper of not more than 20 pages.

2. This paper (or papers) would be distributed to other members of that specific subtopic group.

3. The members of the subtopic group would be required to prepare a response to the position paper (papers) of not more than 10 pages.

4. These response papers would then be distributed to all members of the subtopic group prior to the workshop. The objective is to have all participants arrive at the workshop having given some thought to the development of a consensus or collaborative effort through the integration of all the responses.

5. At the workshop the papers would be reviewed by the subtopic groups and by the entire workshop; modified, retyped, and again reviewed by the separate subtopic groups and the entire workshop. After the workshop, the reports would be turned over to the workshop coordinator for final editing and publishing.

6. The workshop agenda would be as follows:

The final document would not only represent the current state of research and knowledge but also, based on the interaction of various distinguished

AGENDA

Day 1		Day 2		Day 3	Day 4
	9 a.m.	Plenary Session: welcome and outline of objectives of workshop.		Plenary Session: Consensus of papers from Groups 1 & 2 presented.	Plenary Session: Consensus of papers from Groups 3, 4, & 5 presented.
	10 a.m.	Groups meet individually to combine responses.	**10 a.m.**	Groups meet individually to combine responses. Papers retyped.	Recommendations and final report for whole workshop.
		Lunch 12-1 (each day)			Luncheon meeting of group chairmen 12-2 p.m. (or later)
		Plenary Session Papers from Groups 1 & 2. Discussion and recommendations for consensus (all participants).		Groups meet individually (cont.)	
			4 p.m.	Group 3 paper prepresented. Discussion by all participants.	
Dinner meeting of group chairpersons.		Dinner 5-7 p.m.		Dinner 5-7 p.m.	
Informal reception (all participants) 7:30-9:30 p.m.		Groups 1 & 2 meet individually to incorporate recommendations. Papers retyped.		Plenary Session: papers from groups 4 & 5. Discussion and recommendations for consensus (all participants). Papers retyped.	

professionals, a systematic plan for the future.

SIGNAGE

The following suggested research on signage was formulated from previous work and joint discussions involving Dr. Blasch and Drs. U. Kecsy and L. Ross of the Waisman Center on Mental Retardation and Human Development.

Research Need. A comprehensive and systematic study needs to be undertaken to study the standardization of signs and sign placement.

In order to be effective in transmitting information a sign must both be seen and correctly interpreted. Being seen requires that the sign be registered on the appropriate part of the retina, in most cases the fovea. This occurs either because the sign is in the normal scan path of the individual or the individual visually searches for the sign. In the latter case the scanning search may occur randomly, in accordance with some general visual-search strategy, or in terms of past experience and the associated probabilities with respect to its possible location (that is, predictable location).

Once a sign is visually located the question becomes one of the physical characteristics of the sign and whether or not they are such that the information can be unambiguously extracted and interpreted both by those with and those without visual handicaps. Obviously features such as size, contrast, border, configuration, and type font are involved, and all undoubtedly interact in determining the effectiveness of a sign.

Given that such factors affect the usefulness of signage, the question becomes one of determining how to optimize both the location and physical characteristics of signs. Research involving the use of objective eye position and scan-path information can greatly contribute to the efficient and accurate determination of what constitutes good signage, particularly with respect to the needs of those with visual handicaps. The latter is an important point since what may constitute an adequate sign for those without a visual handicap may be unsatisfactory for someone who is visually impaired.

Proposed Research: Optimal Sign Locations. One sign location question concerns the areas most likely to be scanned in any particular situation. For example, when faced with intersecting hallways do individuals tend to look at any particular location or locations in order to obtain information, for example, directions to particular room numbers? Also, and perhaps more importantly, do those with visual handicaps display any particular scanning pattern, and do they differ from those of individuals without such handicaps.

The collection of normative eye movement data describing how individuals scan common environmental locations where signage information is likely to be encountered could be accomplished in a laboratory setting by displaying common traveling situations and recording the eye movements made in response to the scene. Various aspects of the scene, e.g., light level, "busyness" of wall and floors, could be varied to determine the factors that affect scan patterns and thus optimal sign locations. Similarly, the display could be distorted or blurred to simulate various visual problems, and the scanning behavior obtained under these conditions compared to that actually exhibited by a sample of those with visual handicaps. If the data collected under these conditions proved to be similar, it would be possible to collect a great deal of data efficiently by simulating visual handicapping conditions. In such research the latency to obtain the information or the probability of being able to determine the sign's content could be used to evaluate different sign locations. After this initial data has been collected, people with various visual impairments could be tested in the laboratory and then in the "real world."

Another aspect of sign location is the usefulness of background contrast or other aids in helping to locate signs. The procedures described above could be used to determine if such location aids could be used to improve the visibility of signs and increase the probability that an individual would locate the information. The relative attention value of sign location aids could be measured in terms of the probability and latency of initial eye movements being made to each configuration.

Note that these tests could be carried out with signs located in various actual or prototypic situations. Indeed it might be expected that the optimal characteristic of signage would depend upon the particular situation, hallway, lobby or elevator, and such factors as the ambient light level, wall and floor color and contrast, and the contrast of the sign with it's surround.

Proposed Research: Optimal Sign Characteristics. Besides questions of sign location, the physical characteristics of signs could be tested by eye movement information in order to determine those factors that are related to signage effectiveness for all populations. Procedures similar to those described above with respect to investigating sign location could also be used to study the effects of various sign characteristics. Consider the situation where it is desired to determine the relative effectiveness of some aspect of a sign, for example, color, contrast with background, physical layout of sign. Such factors could be systematically varied and the effects evaluated by analyzing eye movements while:

1. determining the time required to locate and read the sign correctly as indicated by the latency to make a correct manual or verbal response regarding the sign's information;

2. determining the probability of correctly obtaining the sign's information from very brief presentations of the sign (eye position information could be used to insure the sign was at the point of regard when it was presented);

3. presenting two or more variations of a sign in which some characteristics are varied in order to determine the relative attentional value of each configuration. This would probably best be carried out with a paired comparison procedure, or something analogous.

It is also important to investigate the functionally important characteristics of signs through an examination of eye movements while an individual is observing a sign. For example, such data might indicate that some aspect of a sign distracts from its more important informational aspects. Further, numerous eye movements and the time spent on a part of the sign could suggest ambiguity in the manner in which the information is presented. Such an evaluation would be of particular importance in the case of low vision individuals where the problems caused by confusing or poorly located signs might be multiplied by virtue of the handicap. The same value would also be true for developmentally disabled individuals.

Proposed Research: Contrast. Contrast is an important sign characteristic. Contrast sensitivity tests are as powerful as are audiograms. In a recent study (Evans and Ginsburg, 1982) the results provide evidence that contrast sensitivity is a better predictor than visual acuity for complex visual performance (discriminating road signs). Contrast sensitivity testing to various signs can be added in the previous studies. In addition, work can also be done to process the material through an "inverse" filter so that the material should be easier for visually impaired persons to see. The basic procedures described previously could be used with some additions.

Proposed Research: Methodology. Eye position and eye movements in signage research would best be analyzed through the use of two modes of eye movement measurement. The first is a Narco Biometrics Eye-Trac which utilizes reflected infrared light. Eye movements detected by the Eye-Trac are processed by a laboratory computer and recorded by means of a polygraph and/or an XY plotter that records the scanning pattern made to the presented scene. This system provides for highly accurate recordings of eye movements (approximately .5 degrees of visual angle).

The second mode of recording eye movements involves the use of electro-oculography (EOG), in which the naturally occurring corneo-retinal potential is recorded by means of electrodes on the skin. This method would be of particular value when individuals need to wear glasses or visual aids that would preclude the use of the Eye-Trac equipment.

Stimuli would initially be presented by means of either slides or computer controlled displays. Slide presentation would have the advantage of permitting actual scenes and signs to be presented with onset and presentation time controlled to +2 to 3 milliseconds through the use of electronic shutters. Display presentation has the advantage of interactive computer control so that, for example, perspective can be changed during viewing to simulate eye movement of the viewing individual. As an extension of these simpler procedures, actual scenes could be videotaped with camera movement that would correspond to an individual's walking, and that videotape shown on a screen while eye movements were being monitored. Similar experiments would then be done with visually impaired individuals as well as developmentally disabled persons in real world situations.

In summary, the use of eye movement information could be quite valuable in determining the most effective signs and their optimal location. Empirical research of the sort described above should provide a data-base that could greatly aid in making decisions about signage and be of particular value in permitting informed decisions to be made for codes and standards regarding the optimal sign usage for individuals with visual handicaps, developmental disabilities as well as elderly persons.

Proposed Research: Raised Vs. Recessed Letters. As discussed in Section One, there is little research data to support either raised or recessed signage. This step must be completed before size, type of lettering, or material can be specified. It is imperative to consider not only blind and visually impaired persons but also individuals with brain injury and learning disabilities. Some individuals with learning disabilities, even though they have normal vision are being taught to read via touch (braille). Therefore, early consideration of all of these groups in the research with haptic (tactual) signage may prevent myopic recommendations. Studies could be designed to compare raised and recessed letters and/or symbols of various sizes and dimensions. Data could be gathered from large samples of user groups taking into account age, type of handicap(s), legibility of signs, and speed of access.

Proposed Research: Symbols. In Section One, there was considerable discussion regarding symbols (color, placement, variety, etc.). Most of the research dealt with symbols for physically handicapped individuals. However, research is virtually nonexistent regarding the use of symbols to communicate information to individuals who are retarded, brain injured, learning disabled as well as individuals with other types of handicaps. Before too much time, energy and money are invested in incorporating specific symbols, it is critical to investigate the most appropriate and communicative symbols that can benefit the greatest number of users. Therefore, research should be done in which a variety of symbols are tested with individuals who have varying functional limitations (mental retardation, brain injury, etc.). Experimentation should also consider other forms of symbols such as the potential use of Blissymbols or modification of these symbols.

BUILDING CONFIGURATION

Research Need. Comprehensive research is needed on building shape and relative orienting/disorienting qualities.

Proposed Research. The work cited in Section One by Weissman (1979) is a sample of the type of research needed. This research on the cataloging of spatial configurations and effects on orientation should be expanded to include a more diverse ethnographic study. Therefore certain shapes could be studied with individuals who are blind, developmentally disabled, physically handicapped, etc., to delineate specific aspects that lead to wayfinding problems. This information would be valuable to architects, particularly when trying to design buildings for extensive use by handicapped populations, for example, group homes, retirement homes, hospitals. The second phase of this research would involve the testing of countermeasures. It is not enough to identify the problem areas with respect to spatial configurations; it is important to develop a catalog of countermeasures such as signage, highlighting main entrances, maps, etc., that could diminish the disorienting effects of various designs.

TRAINING

Research Need. The possibility of providing appropriate instructions/training for handicapped individuals to use the environment must be explored.

Proposed Research. It is vital that training and/or appropriate strategies are available for individuals to maximize the use of various environments. Studies dealing with developing taxonomies of reference points (Sadella, Burroughs & Staplin, 1980) are very important for identifying what to teach a person. Many times if an individual is given a problem solving strategy (for example, what are good reference points), it can resolve the problem without the necessity of building modifications, extensive costs, etc. In a recent study (Blasch, 1982), handicapped individuals were trained to travel independently (maintain orientation), go shopping, and utilize public transportation. While the primary group of clients served were mentally retarded, other individuals served were hearing impaired, emotionally disturbed, learning disabled, or were persons with a cardiac disability, muscular dystrophy, or emphysema. The major impact of this training was the savings of over $117,000 per year on transportation costs for just 36 of the individuals trained. The significance of this study is that many individuals need training to travel in the environment and that in some cases what was considered a barrier or problem could be solved by teaching a person to use an appropriate problem-solving strategy.

The previous studies that have been suggested cannot be done in isolation but must be done in concert with training research.

Once data is gathered on signage, building configurations, etc., it is imperative to test these results and see if training is needed for implementation. Information may then be provided by maps, auditory directories, manuals for suggested wayfinding strategies and signage to facilitate the orientation of handicapped individuals.

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APPENDIX A: Tables from the Work of Dr. Templer on Tactile Surfaces, Recommendations and Detection Methods

Source, Templer, J. Design Guidelines to Make Crossing Structures Accessible to the Physically Handicapped, March, 1982, Final Report, U.S. Government Federal Highway Administration Office, Research and Development, Environment Division, Washington, D.C. 20590.

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TABLE B1
PRIMARY DETECTION METHOD AND RECOMMENDATIONS

PANEL #	RECOMMENDATION	DETECTION METHOD	MATERIAL
1	0	T	Concrete
2	1	S/T	1/16″ Thermoplastic on wood on concrete
3	1	S	Steel on concrete
4	0	T	1/16″ Neoprene on concrete
5	1	T	1/4″ Corrugated plastic on concrete
6	0	T	Concrete
7	0	T	1/4″ Neoprene on concrete
8	1	T	Steel on thermoplastic on concrete
9	1	T	1/16″ Neoprene on concrete over cavity
10	1	S	Plywood over cavity
11	1	S	Plywood over cavity
12	1	S/T	Concrete over cavity
13	1	S/T	Wood over cavity
14	2	T	1/4″ Thermoplastic on concrete over cavity
15	0	T	Concrete over cavity
16	1	S/T	1/4″ Neoprene on plywood over cavity
17	0	T	Concrete
18	1	S/T	1/16″ Thermoplastic on steel on concrete
19	1	S	Steel on concrete
20	2	T	1/16″ Thermoplastic on concrete
21	1	S/T	1/16″ Thermoplastic on concrete
22	0	T	Concrete
23	0	T	1/8″ Neoprene on concrete
24	1	S/T	Steel on steel on concrete
25	1	S	1/16″ Neoprene on wood on cavity
26	1	S/T	Steel on cavity
27	1	S/T	1/16″ Neoprene on Neoprene on cavity
28	0	S/T	Concrete on cavity
29	1	S/T	Steel on cavity
30	0	T	1/8″ Neoprene on concrete over cavity
31	0	S	Concrete over cavity
32	1	S/T	1/8″ Neoprene on steel over cavity

T = Texture
S = Sound
S/T = Sound and Texture

0 — Not Recommended
1 — Highly Recommended
2 — Recommended

TABLE B2

TEST TRACK COLOR PATTERNS FOR VISUAL CONTRAST SUBSAMPLE

PANEL NO.	COLOR DESCRIPTION
1	Alternating ¼″ wide Orange and ¼″ wide White bands
2	Alternating ¼″ wide White and 2″ wide Green bands
3	Alternating ¼″ wide Yellow and 2″ wide Black bands
4	Alternating 2″ wide Yellow and 2″ wide Black bands
5	Solid Orange
6	Alternating 2″ wide Yellow and 2″ wide Black bands with ¼″ concrete groove between bands
7	Alternating ¼″ wide White and 2″ wide Red bands
8	Alternating 2″ wide Yellow-Green and 2″ wide White bands
9	Alternating ¼″ wide Yellow and ¼″ wide Black bands
10	Alternating 2″ wide Orange and 2″ wide White bands with ¼″ groove between bands
11	Alternating ¼″ wide White and 2″ wide Green bands
12	Alternating 2″ wide Red and 2″ wide White bands
13	Alternating 3½″ wide Yellow-Green and 3½″ wide White bands
14	Alternating ¼″ wide Black and 2″ wide Yellow bands
15	Alternating 2″ wide Orange and ¼″ wide White bands
16	Alternating 2″ wide Orange and 2″ wide White bands
17	½″ Red Squares on White Surface
18	Pirelli Pattern: ¾″ Red circles on White background
19	⅛″ dots on ½″ centers: Yellow circles on Black background
20	Pirelli Pattern: ¾″ Yellow-Green squares on White background
21	¼″ Yellow squares on Black background
22	½″ Yellow-Green squares on White background
23	¾″ Yellow-Green squares on White surface
24	½″ Orange circles on White surface

APPENDIX B:

Analysis of 40 U.S. Building Codes and Regulations Pertaining to Orientation and Wayfinding

Prepared by:

Sally Free
Architectural and
Transportation Barriers
Compliance Board
Washington, D.C.
8/26/82

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
ANSI-1980		x	x	x	Elev. Floor Desig.	x	Provide if Fac. is accessible or is identified	If desired, left side; no border	3:5 to 1:1	1:5 to 1:10	1/32"; 5/8" to 2" high raised or indented 1/4" indented	Raised or indented 1/32"	Sans serif (tactile) arabic	Elev. left side floor -5'-0" 2" high	6'-8"	Req.	Either light to dark or dark to light	Tactile		
ANSI-1960					Rooms Offices Exit									4'-6" to 5'-6"; 5'-0" pref.	7'-0"	Req fire es-cape				
Alabama 1976					Rooms Offices									4'-6" to 5'-6" (3'-0"p) R or L Latch 8"		Req				

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Alaska 1981-82		x	x	x	Elev. Floor Desig.	x	Provide: If fac. is access, is ident.	If desired left no border	3:5 to 1:1	1:5 to 1:10	1/32"; 5/8" to 2" high; raised or indented --- 1/4" indent	Raised or indented 1/32"	Sans Serif (tactile)	Elev. left side floor design; 2" high; 5'-0" aff.	6'-8"	Req.	Either light to dark or dark to light	Tactile		
Arizona 1976 1981					Rooms Offices		Toilet rooms	If desired	3:5 to 1:1 (adv)	1:10 but no less than 1/4" adv)	1/32" min 5/8" to 2" (adv) raised or recessed	1/32" min	Sans Serif (advisory)	Right or left; 4'-6" to 5'-6" (5'-0" pref)	7'-0"	Req.	Light on dark pref.	Tactile		
Phoenix 1979							Unless all are access. Entrances; Toilet rooms; Routes													
Arkansas 1982	x		x		As req; Temp. signs are excepted		As req; min. dim. given		3:5 to 1:1	1:5 to 1:10	1/32"; 5/8" to 2" high; --- 1/4" incised	1/32"	San Serif (tactile)	4'-6" to 5'-6"; latch side	6'-8"	Req.	Light on dark preferred	Tactile	As req	Matte finish on matte background

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Calif. 1982	x					x	White on blue; color # 15090 in FS 595a exceptions to aboved permitted	Gr. 2; .1" on center .2" between cells; Raised .2"	3:5 to 1:1	1:5 to 1:10	Raised or recessed 1/32"; 5/8" high	Recessed 1/4" min stroke width	Sans serif (tactile)		6'-8"		Either light on dark or dark on light		Exist. Bldg: directions posted in lobby Geometric symbols	Pedest. traffic control color coded 48" buttons
Col. 1973					Rooms Offices									R or L; 4'-6" to 5'-6" (5'-0"p)		Req				
Conn. 1979					Rooms Spaces Offices									R or L; 4'-6" to 5"-6" (5'-0"p	7'-0"'	Req				

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Sign-age req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Del. 1981					Rooms Spaces		Parking; Passenger loading; Accessible entrance; Accessible toilet and bathing facilities		3:5 to 1:1	1:5 to 1:10	Raised or incised; 1/32"; 5/8" to 2" high	Raised or incised; 1/32"; Incised 1/4" stroke	San serif (tactile)	Latch side; 4'-6" to 5'-6"	6'8"	Req.	Light on dark preferred			Matte finish on matte background; Uniform; Directional
D.C. 1980					Rooms Offices Spaces									4'-6" max; R or L		Req.				
Fla.					Public facil.; Emerg.						Block; 1/2" high			3'-0" to 5'-0"; 4" to 12" from door jamb		Req.	Contrast			
Ga. 1982				x	Rooms Offices									R or L; 4'-6" to 5'-6" (5'-0" pref)		Req.		Identifying features for blind		Telephones: -for hearing impaired

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Restrooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Idaho 1976	*				Elevators		White on blue; All accessible entrances	Elev. control panel; Elev. door casings										Raised arabic numerals; Braille embossed to right of panel on door casings; 42" aff	Signs in bldg directory; main lobby, or accessible entrance	
Illinois 1981	Maximum visual exposure Except. if audio tapes, guides, Braille brochures are available				Informational signage, maps, directional signs, ident., rooms & spaces		All Major entrances, Public toilets, Circulation paths, Maps, Accessible parking		3:5 to 1:1	1:6 to 1:10	1/32"; sharply defined edges; 5/8" high			Latch side; 4'-6" to 5/8" high			Pref. light on dark		Directions	Glare-free surfaces

*Post at accessible entrance.

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Sign-age req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Iowa 1977							Consider-ation; Standard & con-venient	Blue with number certi-fying review								Recom-mended				
Kansas 1979							At en-trance if bldg is in com-pliance													
Ky. 1981		x	x	x			Parking; all acces-sible facilities		3:5 to 1:1	1:5 to 1:10	1/32"; raised or incised; 5/8" to 2" high	1/32"; raised or in-cised; Incised 1/4" stroke width	San serif (tactile)	Latch side 4'-6" to 5'-6"			Pref. light on dark			Matte finish: back-ground; Exter-ior; direc-tion
La. 1977							All re-modeled facilities w/direc-tions to access fac.													
Maine 1977					Elev			Elev												

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Sign-age req.				Tactile Req.	Requirements for Tactile, if provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Mo. 1980							Accesible entrances and bathrooms; Parking; Circulation Directional signs		5/8" to 2" high					Adequate	6'-8"		Dark on light or light on dark			
Nebr.					Normally used									4'-6" to 5'-6" latch side		Req. fire escapes		Tactile advisory: 1/32" min 1/2" min height, raised preferred Hoistway: advisory, 2 1/2" min. 1/32"		
Nev. 1980					Rooms Spaces		Parking Passenger loading Access entrance Access toilet & bathing		3:5 to 1:1	1:5 to 1:10	Raised or incised 1/32"; 5/8" to 2" Incised- 1/4" stroke width	Raised or incised	San serif (tactile)	Latch side 4'-6" to 5'-6"	6'-8"	Req	Light on dark pref			Matte finish on matte back-ground; Uniform Directional

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Md. 1980					Elev		Parking				1/2" high; .030" raised		Block; (tactile - elev)				Req.- elev	Left of controls; Hoist-ways 5'-0" 2" high; .030"	Posted near eleva-tors	
Mich.					Floor design			Elev										Floor design		Parking
Mass. 1982				*	Elev.; Floor desig; Eqress		Parking; Inaccessi-ble en-trances; All toilets w/direc-tion to access. fac.; Maps, signs	Elev-(adv); Egress (adv)			Elev; 1/2" high; raised .03; Egress; raised 1 1/4"			4'-6" to 5'-0"; less than 18" from jamb	Ext-high enough		Elev; Egress	Left of floor buttons; Hoistways 2 1/2" min.; .030"		
Minn. 1980					Spaces; Floor desig; Elev									4'-6" to 5'-0'; Door jamb side (tac-tile)		Req		Raised or re-cessed; hoistway 3'-6" - 4'-6"		

*Apts., Rooms, Toilets, Elev.

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
NC 1981					Floor Desig.; Normally used		Parking (mutcd R7-8) Green & white	If desired			Floor desig- 2 1/2" min; Raised .030 Raised or recessed			4'-6" to 5'-6" on latch side		Req. Fire escape	Floor desig (tactile)			
Ohio 1978	*		*	*	Floor desig (adv); 2" raised; Tele (adv); Elev (adv)		Entrance (advisory); New bldg. Remodeled bldg.; Restrooms; Telephones; Signs & maps	If desired			Raised 1/2 to 1" Rasied or recessed > 1"; 164" (adv.); .030 raised or incised (adv)		Straight forward & legible	4'-6" to 5'-6" on latch side	High enough		Light on dark is preferred			Illuminate signs (adv); Parking (adv); Concise /Direct; Uniform
Oregon 1979					Rooms		Facilities for phys. handicapped	If desired						4'-6" - 5'-6" on latch side (tactile)		Req. fire escape				
SC 1976							Entrance of fully accessible facility													

* Adv.

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
NJ 1982					Routes		Entrances, Parking lots, Toilet facilities		3/4" high (tactile & flush)				Relief	4'-6" C.L.; door or wall on latch side		Req. fire escapes	Contrast in lettering	Elev lobbies contrast colors		Glass doors-color band; Color circ. routes & Stairs
NH 1979	*				Tele-phones	**	Parking (6'-8"); Telephones Access entrances; Access toilets; Circulation routes; Directional signs	Tele-phones; Egress (adv)			Raised - 1/2" high 1/8" thick (tele-phones); Raised 1/8"; 1 1/4 min height			4'-6" to 5'-6" C.L. & within 18" of latch side	6'-8"		Contrast (tactile)			Area code & number
NY 1972					Elev		Parking (adv)	Floor desig (adv) 5'-0"												

*W/directions
**Egress

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Texas April 1981			x	x	Floor desig 2" - 4" 1/8"; When signage is used ' unit for each function		Parking	Left of stand letters (adv). Raised borders discouraged	3:5 to 1:'	1:5 to :10	Hoistways Raised or indented; 5'-0" C.L.; 2'-4" high;- 1/8" 1/32" 5/8" high Raised or incised; Indented; 1/4" width	2" max recommended; Place on left side		5'-0" on latch side within 8" of door	6'-8"	Req	With background	Tactile req., arabic		Tactile to left
Texas Univ.					Rooms Offices Elev		Access facilities, Parking	Tele (adv) Elev explan			Raised or incised			4'-6" to 5'-6" (5'-0" pre) (tactile)			Req			Stairs: contrast riser & tread (adv); Telephones; Main entr; Bldg direct (adv); Red-green should be avoided

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Sign-age req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
Utah					Rooms, Offices Gener-ally used spaces		Access fac.							4'-6" to 5'-6" (tac-tile); latch side			Req. Fire escape			Direc-tory
Vermont 1979					Rooms Offices									4'-6" to 5'-6" (5' pref), (tac-tile), right or left	7'-0"		Req. Fire escape			
Wash. 6/5/1981					Elev con-trols; Public spaces; Toilet rooms; Stairs Loading plat.; Stages; Mech. rooms; Fire escapes hazards		Parking (4'-5"); Entrance; White on blue; Site entrance; Toilets; Exits							Latch side; Raised or grooved; 1/16", 1" to 2"; 5'-6" aff						

SUMMARY OF CODES ON SIGNAGE
8/26/82

	Signage req.				Tactile Req.	Requirements for Tactile, if Provided	Access Symbol	Braille	Width to Height Ratio	Stroke Width to Height Ratio	Tactile Letters/ Numbers	Tactile Symbols	Type Face	Height from Floor (Flush)	Height from Floor (Proj)	Knurl Knob -Danger-	Req. to Contrast	Elevators	Rest-rooms	Other
	Entrance	Emergency	Circulation	Rooms & Spaces																
W.Va. 1974					Elev.; Floor desig						Raised			3'-6" on each side of hoist-way R or L 4'-6" to 5'-6"	7'-0"		Req. Fire escape			Tele-phones opera-ting in-struc-tions
Wyo. 1982					Rooms Offices			If de-sired			Raised or recessed; 1" min			4'-6" to 5'-6"			Req.			Parking

APPENDIX C:

Information Requested
For Technical Paper on
Signage

INFORMATION REQUESTED FOR TECHNICAL PAPER ON SIGNAGE

August 30, 1982

Requested by Sally Free for United States Architectural and Transportation Barriers Compliance Board, Washington, D.C. 20201

OVERVIEW

The following list of questions was submitted to Blasch and Hiatt. A clearly researched and explicit response to each item would be ideal. However, in the absence of concrete, empirically based data on broadly drawn, representative samples, responses based upon the authors' experiences are presented. Several of the items have also been addressed by other resource persons.

These are significant issues and need to be addressed. It is a concern that continued input based on the selected experience of resource people will not satisfy the need for systematically obtained consumer input and research. Without systematic research, surveys such as this one are merely collecting opinions. It is imperative that future decisions are based on data and facts such as Templer's study (see pages 1.29-1.34) rather than a majority opinion (see pages 1.44-1.47).

INFORMATION—WAYFINDING: GENERAL

Respondents:
B = Bruce Blasch, Ph.D.
E = Everett Hill, Ph.D.
L = Lorraine G. Hiatt, M.A.

1. Should information and wayfinding signs and other devices for disabled users be advisory or mandatory?

B & E responded "mandatory" on the presumption that good design and information are a broad need for able and disabled users.

L responded that while the goal might be to offer mandatory systems, to adopt requirements without more specific information on what, where, and how would, at this point, be premature. Therefore requirements for devices should be advisory in all but public buildings and transportation centers where the needs are sufficiently strong to suggest that systems, devices OR signs be mandatory (see pages 1.13, 1.26, 1.44-1.47, 1.48, 3.4-3.6).

2. What type of informational and wayfinding requirements, if any, should be established to enable a disabled person to use the facility? For example, should there be requirements for any of the following (see pages 1.11, 21, 1.12, 1.13, 1.14, 1.15, 1.16, 1.17, 1.22-1.24, 1.25, 1.26, 1.28, 1.43-1.47, 1.48, 3.4-3.7)

a. Information/directional devices?
Yes (all)

b. Entrances?
Yes (B,H)
Yes, (L), if we can indicate (1) the accessibility of the entrance and (2) entrances that are to be used by the public (see page 1.24).

c. Emergency exits and egress route identification?
Yes (B,H)
Yes, (L), but we need to work on the legibility of exit signs, on their height in terms of older and wheelchair users, on glare reduction, and on alternative means of offering information on egress routes for emergency purposes. What about flashing signals? Can a requirement be established that something be done without knowing what? or what will

work for ALL users (see pages 1.24, 1.47)?

d. Rooms, spaces and offices?
Yes(B,H)
L not convinced that all rooms, spaces and offices need labeling, perhaps those used by the public. Would stress placement of labels next to doors and in areas from waist to eye level, with modifications for buildings used by children (see pages 1.11, 1.14, 1.26).

e. Decision Nodes
L would advise signage, especially if building is of a shape or configuration other than a simple, linear layout (see pages 1.7, 1.8, 1.11, 1.13, 1.22-1.23, 1.25, 1.28, 1.29).

f. Floor designations at elevator hoistways?
Yes; L would like to see recessed letters rather than raised (which can shadow), more attention to the contrast between background of label and surface color/texture, and attention to lighting/glare conditions of the environment. Here, a functional requirement, "a label which can be readily discerned both visually and tactilly and when the door is open or closed" might be advisable (see page 1.46).

g. Elevator control panels?
Yes; L would like to see braille and large print, but braille should not be directly on the button. Metal large print on metal panel should not be used. And, whether mandate or advice is offered, label should be large print, contrasting color to background AND buttons and well lit (see pages 1.15, 1.16, 1.46).

h. Elevator call buttons?
Yes. L is concerned that more information is needed or should be applied to considerations such as size/thickness, letter/number width, and location of elevator numerals, and that lighting, glare and contrast factors again be considered (see page 1.46).

i. Restrooms?
Yes. L is concerned that signage reflect information not currently available. For example, if the cubicle is accessible but the route is not completely wheelchair accessible, some appropriate notation is needed. B suggests that a fully accessible notation might be an adaptation of the existing wheelchair symbol with a mark. L would "advise" labels other than esoteric graphic symbols and would place labels at heights readable to persons in wheelchairs (see pages 1.27, 1.45).

j. Circulation Routes
Yes, (B&H); L is supportive of the need to make routes known, but, again, concerned that no universally acceptable method has been developed and would prefer that advice be offered on a variety of workable techniques from human information services and telephones to audio maps, tactile maps, technological guides and signs. Without the ability to specify one method, L is inclined to favor advisory rather than mandatory systems, unless it is possible to mandate without explaining how (see pages 1.13, 1.24, 1.46)?

k. Telephones?
Yes (see page 1.45).

l. Directories
Yes. L is frustrated by the glare and print size which minimize visibility and would accept a combination of directory plus human (or telephone) information source or other means (see page 1.11).

2. What methods are available to provide needed information and wayfinding (e.g., computers,

signs, auditory maps, signal and other auditory devices, colors, shapes, symbols, tactile characters)? How effective are they? Whom do they benefit (see pages 1.11, 1.12, 1.13, 1.18, 1.22, 1.29-1.44, 3.4-3.7)

In the text of the literature review and through the citations (Sections One and Two of this technical paper) some of these systems have been described. For each, we have tried to indicate the state of the art in research. Much more has been developed than studied; therefore it is difficult to adopt any one of these measures (even for able clients) because so little research has been done on the full spectrum of disabled users.

Auditory maps have been developed for visually impaired users but may have implications for the general public, for older persons, and for people with only minor to moderate hearing impairments. However, research is just not there to generalize to these groups.

Computers are being tested in a variety of applications, but are not widely available. Work needs to be done on the uses of computers with populations who do not type or on development of systems which are "user friendly" for disabled people.

The lack of research on signage for impaired persons — even for low vision users — is appalling. The lack of agreement on print legibility seems to stem from the fact that everything is opinion based and not research based.

Colors continue to be a controversial method of orientation. Older people are stymied by many choices because their lenses change (yellow) and they do not perceive colors which are similarly light or of similar dark tones. Contrast in colors seems to be a key to legibility for many users, young and old. However, color is a function of light, texture, amount, cultural familiarity and tone. It is not easy to generalize. No one color seems to be equally visible to all handicapped persons (though research on this is also scarce). Finally, color seems to be a very abstract cue, making it less useful for older people, people with cognitive deficits, or people whose memory is already overloaded with other directional information.

Signal and auditory devices, discussed in the text, are available. Some are quite inexpensive. Others offer tactile as well as auditory output making them more broadly useful. Again, the research is scarce but the ideas are promising.

There is some research on shape recognition for blind persons; however, shapes discussed are often not representative of those real objects we might use as signals. Little research has been done relating shape studies to the orientational needs of older persons and persons with mental or learning problems or multiple disabilities.

Symbols are about as controversial as colors. It would be nice if they worked, but many are so abstract they lack meaning, particularly for older persons, persons inexperienced with symbols used in community life (i.e., those in institutions), and persons with certain cognitive impairments. Until more data are available, it is difficult to recommend one system or type.

Tactile characters are another area which seems worth exploring. One of the most important topics for research would be the relative merits of recessed vs. raised letters for different users. Templer's research on textured ground surfaces is very interesting, though the actual research basis for the recommendations involves very small samples.

Other methods, not included, which ought to be considered are human based systems for orientation: does traning work? How should instructions be given?

Another important issue involves whether wayfinding methods are equally effective if they are rooted in the walls, structure, or ground, or if they are worn or carried by the disabled person.

NON-TACTILE SIGNS

1. What are the minimum and maximum heights of letters, numbers and symbols that should be used?

H & B comment that no definitive research is available to justify a single requirement. L notes that since 1980 there have been some pieces on print legibility (see text, Section Two), but that the issue of sign legibility is still relatively unknown (see pages 1.26, 1.48, 3.4-3.7).

2. What should the character proportion for tactile letters and numbers be?

The lack of research based upon studies of handicapped users made it difficult to respond to this question (see pages 1.48, 3.4-3.7).

3. Should letters, numbers and symbols contrast with their background? How should contrast be measured?

Yes. H suggests that testing be done under different illumination, with persons of varying visual conditions, at various distances, and with a range of color contrasts. B suggests that illumination be specific to location but systematically tested. L suggests that the National Academy of Sciences, Committee on Vision, be used as a resource of the measurement of contrast since they have been looking at similar topics. Also, Dr. R. Secular at Northwestern University has been studying contrast as an aid to visibility and is knowledgeable about a variety of methods which might be simply adapted to obtain a reading of contrast. L adds that not only letters, numbers, and symbols need to contrast, but that the background (sign itself) should contrast with the wall surface (color, texture, light) (see pages 1.18, 1.19-1.20, 1.47, 1.48, 3.4-3.7).

4. What is the appropriate finish for letters, numbers and symbols (e.g., matte or gloss)?

H feels that glare should be considered therefore questions the use of gloss. B recommends that we do need research. L is so compelled by the negative effects of glare for older persons that she would prohibit the use of reflective surfaces and further eliminate or minimize lighting conditions which add to glare. L also realizes that a little bit of glare (reflectance) in some situations can add to visibility (for example, when reading metal, raised letters on a coin); but feels that such points are exceptions when legibility is limited. L could accept non-reflective glass as a means of minimizing some long-standing, glaring surface (see pages 1.8, 1.17, 1.18, 1.19-1.20, 3.4-3.7).

5. What is the appropriate finish of the background? (e.g., gloss or matte)?

See above.

6. Should a specific type face or style be required (e.g., sans serif, serif, Helvetica, Roman)?

H suggests that type face be simple and "clean." B would specify one or two faces and would urge more research with mentally retarded, learning disabled and older population. L would also advise the research, but based on what little has been researched, would suggest Roman (serif) styles of typeface on printed matter and Helvetica (sans serif) for signs where print size is substantially larger (see pages 1.27,1.48,3.4-3.7).

7. Where should interior and exterior signs be mounted (e.g., latch or hinge side of door, on door, height above finished floor/ground surface?

H would place signs on latch side of door about 5' - 6' or 5' - 7' from finished floor. B would place them at 4' - 5' from finished floor on latched side. L would agree to latch side next to door particularly if door is kept open, and would be adverse to signs over 5' (the average height of an older woman) preferring something in the range of 4' to 5' to aid wheelchair users, short people, children and older persons. All point to their differences as an example of the need for information (see pages 1.15, 1.17,1.23,1.46,3.4-3.7).

8. What alternatives to non-tactile signs are available? How effective are they?

H notes that auditory devices (for elevators) are devised to be beneficial to visually impaired persons as are buzzers and bells at crossings. However, is not sure of their efficacy. H also notes that back-up sounds on trucks have been a signal which seems to have benefited some. Auditory guides, in general, are an aid for non-readers or illiterate people. B agrees. L notes that talking signs and computers with vocal/tactile output are in the developmental stages. Also vibrating paging systems might be considered an alternative means of signalling a hearing impaired person (for a fire or fire drill) though there is not research on this. L would also like to see research on flashing lights for exit signs (see pages 1.12, 1.20-1.21, 1.22, 1.29-1.40).

9. Should a performance or design requirement be used?

L advocates performance requirements based upon our current fuzzy, muddled, incomplete state of knowledge and the potential for new technologies to be instructive. Perhaps some stimulating incentive ought to be offered to get innovators to show their research? B and H want to see some requirements, in either performance or design. All are concerned about design requirements without adequate data on a full range of handicapped users (see pages 11, 1.8,3.4-3.7).

TACTILE SIGNS

1. Should tactile signage be required?

H says not necessarily; signs could be tactile and auditory. B would agree to tactile or an alternative to visual. L would advise tactile signs but not braille alone (since the majority of blind and visually impaired users do not read braille) (see pages 1.16, 1.27,1.29-1.34,1.45,1.46).

2. Should tactile signage be advisory?

H says yes; B wonders whether this would preclude some other signage modality which might be better. L would make tactile signage advisory (see pages 1.29-1.34,1.45,1.46).

3. What types of signage should be tactile, if it is required (e.g., information signage, signs at entrances, emergency exits and egress routes, rooms, spaces, offices, decision rooms, floor designations at elevator hoistways, elevator control panels, elevator call buttons, restrooms, circulation routes, telephones)?

H would designate call buttons and panels to be tactile. B would agree to panels, hoistways, offices/rooms, directories, building maps, egress and exit. L would recommend emergency exits, egress routes, floor designations at emergency stairs (not on the list), elevator control panels and call buttons, and restrooms. All note that their recommendations are at best, educated guesses and warrant consumer research (see pages 1.14, 1.16, 1.25, 1.29-1.34, 1.43-1.44,1.46,1.47,3.6).

4. What type of signage should be tactile if it is advisory?

H says, see above. B notes that research is really needed, but would require design options, above. L would advise anything that was not required (from list above) and advise markings on the rest with the possible exception of telephones which seem to offer tactile cues already (in terms of order) or which can be used by obtaining operator (see pages 1.29-1.34, 1.43-1.44,1.46,1.47).

5. What are viable alternatives to tactile signage? Where and when should or could they be used?

H suggests that visual and auditory systems and person-information centers as well as telephones are alternatives. B agrees and adds auditory and kinesthetic cueing signals. L refers to the technical devices, acknowledging that they are not widely used but they might offer alternatives. None will respond to where or when without some input from the users (systematically obtained and from broadly based sampling techniques)(see pages 1.14, 1.20-1.21, 1.29-1.38, 1.40, 1.41, 1.42).

6. Should braille be required? Advisory? Where and when should or could braille be used?

H would not require it, but would advise it on elevator panels, referring to buttons. B would not require it and is not sure he would advise it except at elevator hoistways and doors and for elevator buttons. If simple recessed letters or tactile symbols are available, L would not require the braille. But L would require a tactile marking system. L also would not be adverse to advising braille, particularly in public buildings, residences where braille readers lived, facilities where blind persons lived, and hotels and department stores (see pages 1.16,1.46,1.47).

7. What should be the character proportion for tactile letters and numbers (i.e., appropriate width-to-height ratio, stroke width-to-height ratio)?

None know. L suggests that the Human Factors Society be contacted for possible (unpublished or published) research on that matter (see page 3.7).

8. Should tactile characters and symbols contrast with their background? If so, how should this be measured?

All would have them contrast both visually and tactually (see page 3.7).

9. What is the appropriate finish for tactile characters and symbols (i.e., matte, gloss, smooth, rough)?

H says matte; B recommends a finish that provides the best contrast without being rough; L urges it not be smooth (hands sweat on it) nor glossy (as it cannot be visually read), and would urge research on velour-like textured materials. Not sure.

10. Should tactile characters and symbols be raised or incised?

H says raised; B does not know. L says recessed so that they do not shadow (causing them to lose visual readability for low vision and sighted users) (see pages 1.27, 3.7).

11. If raised, what is the appropriate height?

There is no research indicating that it should be raised or to what height (see page 1.27).

12. If incised, what is the appropriate depth?

Again, no research (see page 1.27).

13. What are the minimum and maximum sizes that should be used for tactile characters?

H would not make them larger than one hand's span. B and L don't know. L is concerned that they not be super graphics, that is, so large as to be outside of the visual field of sighted, older and visually impaired persons.

14. Should a specific type face be required for tactile letters?

All agree that because of a lack of research, it is not appropriate to stipulate a requirement at this time.

15. Where should interior and exterior tactile signage be mounted?

See non-tactile signs, Q. 7. (See pages 1.24, 1.28, 1.43-1.44)

16. Should performance or design standards be used?

L prefers performance because of the lack of research and even practical experience.

17. Are tactile maps effective?

H notes that some are, some are not. B notes that it depends on the individual and on the maps, but that they are generally NOT effective. B suggests that auditory maps combined with a simple raised line maps are more effective than tactile maps alone. L refers to the ongoing research at University of New Mexico by Dr. Wolfgang Preisser on tactile mapping for college campuses — which points out that little is known about their use by the non-student population who are the majority of severely visually disabled persons (see pages 1.27, 1.37, 1.38, 1.42).

ACCESS SYMBOL

1. Where and when should the access symbol be used (see page 1.45)?

a) Should it be used to identify accessible facilities?
All agree, yes (see page 1.28).

b) If all elements and spaces within a facility meet the applicable code, should the access symbol be used only at entrances; should it be provided at all accessible elements and spaces; or should it be placed at inaccessible elements and spaces with directions to accessible elements and spaces?
H would place it at front entrances. B would devise some symbol to differentiate "this is accessible" from "want to know more about what is accessible?" L would use it at entrances if they are accessible and then provide some immediate explanation of what is and is not accessible. L would not place it at inaccessible elements and spaces and would be interested in pursuing B's idea for differentiating what is accessible from a center for accessibility information. L wants to know why there is an emphasis to define what is accessible for wheelchair users without notifying deaf persons of hearing amenities.

c. Should it be used at specific locations or at inaccessible elements and spaces to direct the user to the accessible facility?
B and H would use it at both places. L would use one symbol for accessibility and another for information.

d. Should the mounting height and location of the accessibility symbol be standardized?
L notes that most are outside of the visible range of wheelchair users, especially persons with limitations in the neck and shoulder areas (see page 1.17).

2. Should specific colors be specified (e.g., white on blue)?
H says yes; B and L feel that color contrast is important, but that some latitude be offered. Should a specific number be used to designate the precise color required? L wants to know whether that level of precision can be specified; for example, have the likely choices been studied vis-a-vis color deficient individuals (including older people for whom perceptions of blues may be distorted) (see pages 1.17, 1.18-1.20, 1.47)

3. Should specific sizes be established in accordance with location (interior, exterior) and viewing distance?

B and H say yes. L would like to see that they be established based upon systematically obtained input from consumers (see pages 1.46, 1.47).

4. Should the access symbol be required to be used at the following locations: parking spaces designated as reserved for the physically handicapped? passenger loading zones? accessible entrances? accessible toilet and bathing facilities? directional signs? telephones?

All agree, Yes to all (see page 1.45).

5. Should there be different requirements for new, existing and remodeled facilities?

All agree, yes.

ILLUMINATION

1. What are the appropriate lighting conditions for blind people and visually impaired users?

B and H say it depends upon situation. L states that substantial data is available indicating that standard lighting recommendations are inadequate for older persons trying to read but there is not good quality information, as B & H note, on situations/specific environments. L would like to see this as a priority goal, and notes that British researchers do have some studies underway on the topic (see pages 1.7, 1.16-1.20, 1.27, 1.28, 1.45, 1.46, 1.48).

2. Should performance or design standards be established?

B and H want to see standards of either sort. L would work first toward performance standards, since lighting may be a function of several interactive factors rather than light alone. L would also request research on the relative problems of fluorescent lighting for older, low vision, mentally retarded and learning disabled persons (see pages 1.45, 1.46).

HV1708
Or16 Orientation and wayfaring
W364
C.2

DATE DUE

HV1708
Or16 Orientation and wayfarin
C.2

DATE	ISSUED TO

AMERICAN FOUNDATION FOR THE BLIND
15 WEST 16th STREET
NEW YORK, N.Y. 10011